

Comprehensive Long-Term Environmental Action Navy (CLEAN) II
Contract No. N62742-94-D-0048
Contract Task Order No. 0078

Health and Safety Plan
Pre-Design Investigation
Operable Unit 2C
Landfill Sites 3 and 5
Former Marine Corps Air Station, El Toro
California

Prepared for

Department of the Navy
Commander, Southwest Division
Naval Facilities Engineering Command
San Diego, California 92132-5190

Prepared by

Earth Tech, Inc.
700 Bishop Street, Suite 900
Honolulu, Hawaii 96813

March 2002



DEPARTMENT OF THE NAVY
SOUTHWEST DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
1220 PACIFIC HIGHWAY
SAN DIEGO, CA 92132-5190

5090
Ser 06CC.DG/0278
March 22, 2002

Ms. Triss Chesney
State of California Environmental Protection Agency
Department of Toxic Substances Control
Base Closure Unit – Southern California Operations
5796 Corporate Avenue
Cypress, CA 90630-4700

Dear Ms. Chesney:

Subject: INTERIM FINAL WORK PLAN AND HEALTH AND SAFETY PLAN, PRE-
DESIGN INVESTIGATION, OPERABLE UNIT 2C, LANDFILL SITES 3 AND 5,
FORMER MARINE CORPS AIR STATION (MCAS), EL TORO, CALIFORNIA

Provided for your review are the subject documents, dated March 2002. The majority of the information in the Interim Final Work Plan has been previously reviewed as part of the August 2000 Draft Project Work Plan for pre-design activities at IRP Sites 3 and 5. Also, we have addressed all comments and significant issues on the Draft Project Work Plan, in our Response to Comments that were reviewed and approved in December 2001. The Work Plan is being submitted as an interim document rather than a final document, however, at the request of the BCT, as there is new information, which was not formerly addressed in the Draft Work Plan. We request that you review the Interim Final Work Plan and Health and Safety Plan, and provide any additional comments by 22 April 2002.

The Interim Final Work Plan and Health and Safety Plan detail the objectives and procedures for the collection of data to support the remedial design for IRP Sites 3 and 5, including APHO 46 and MSCR 2, at MCAS El Toro. We will also provide an overview of the strategy to include APHO 46 and MSCR 2 into the remedial design for Sites 3 and 5 at the March 27, 2002 BCT meeting.

Should you have any questions regarding the enclosed documents, please call the Remedial Project Manager, Ms. Kyle Olewnik, at (619) 532-0789, or myself at (619) 532-0765.

Sincerely,

DEAN GOULD
Base Realignment and Closure
Environmental Coordinator
By direction of the Commander



DEPARTMENT OF THE NAVY
SOUTHWEST DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
1220 PACIFIC HIGHWAY
SAN DIEGO, CA 92132-5190

5090
Ser 06CC.DG/0278
March 22, 2002

Ms. Patricia Hannon
California Regional Water Quality Control Board
Santa Ana Region
3737 Main Street, Suite 500
Riverside, CA 92501-3339

Dear Ms. Hannon:

Subject: INTERIM FINAL WORK PLAN AND HEALTH AND SAFETY PLAN, PRE-
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FORMER MARINE CORPS AIR STATION (MCAS), EL TORO, CALIFORNIA

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Environmental Coordinator
By direction of the Commander



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SOUTHWEST DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
1220 PACIFIC HIGHWAY
SAN DIEGO, CA 92132-5190

5090
Ser 06CC.DG/0278
March 22, 2002

Ms. Nicole Moutoux
U.S. Environmental Protection Agency, Region IX
Hazardous Waste Management Unit (SFD 8-2)
75 Hawthorne Street
San Francisco, CA 94105-3901

Dear Ms. Moutoux:

Subject: INTERIM FINAL WORK PLAN AND HEALTH AND SAFETY PLAN, PRE-
DESIGN INVESTIGATION, OPERABLE UNIT 2C, LANDFILL SITES 3 AND 5,
FORMER MARINE CORPS AIR STATION (MCAS), EL TORO, CALIFORNIA

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Sincerely,

DEAN GOULD
Base Realignment and Closure
Environmental Coordinator
By direction of the Commander

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QUESTIONS MAY BE DIRECTED TO:

**DIANE C. SILVA
RECORDS MANAGEMENT SPECIALIST
SOUTHWEST DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
1220 PACIFIC HIGHWAY
SAN DIEGO, CA 92132**

TELEPHONE: (619) 532-3676

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5090
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March 22, 2002

- Enclosures: 1. Interim Final Work Plan, Pre-Design Investigation, Operable Unit 2C, Landfill Sites 3 and 5, Former Marine Corps Air Station (MCAS), El Toro, California
2. Interim Health and Safety Plan, Pre-Design Investigation, Operable Unit 2C, Landfill Sites 3 and 5, Former Marine Corps Air Station (MCAS), El Toro, California

Copy to:

Ms. Triss Chesney
California Environmental Protection Agency
Department of Toxic Substances Control
Base Closure Unit
Southern California Operations
5796 Corporate Avenue
Cypress, CA 90630-4700

Ms. Patricia Hannon
California Regional Quality Control Board
Santa Ana Region
3737 Main Street, Suite 500
Riverside, CA 92501-3339

Ms. Polin Modanlou
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Commander
Mr. Wayne D. Lee
Marine Corps Air Bases, Western Area –
AC/S Environment Code 5AU
MCAS Miramar
P.O. Box 452013
San Diego, CA 92145-2013

Mr. Jerry Werner (1 copy)
Restoration Advisory Board Co-Chair

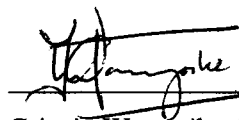
Ms Marcia Rudolph
Restoration Advisory Board
Subcommittee Chair

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Health and Safety Plan
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Pre-Design Investigation
Operable Unit 2C, Landfill Sites 3 and 5
Former Marine Corps Air Station, El Toro, California
Contract No. N62742-94-D-0048
Contract Task Order No. 0078

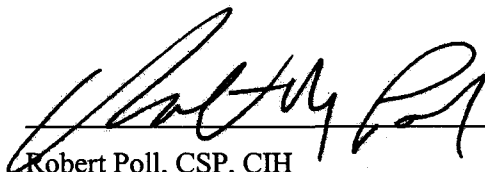
By signing below, I acknowledge that I have reviewed and hereby approve the Health and Safety Plan for the Pre-Design Investigation for Operable Unit 2C, Landfill Sites 3 and 5, Former Marine Corps Air Station (MCAS) El Toro California. This Health and Safety Plan has been written for the exclusive use of Earth Tech, Inc., its employees, and subcontractors. The plan is written for the specified site conditions, dates, and personnel, and must be amended if these conditions change.

Plan Approved By:



Crispin Wanyoike, P.E.
CTO Manager
Earth Tech, Inc., Long Beach

Date: 3/22/02



Robert Poll, CSP, CIH
CLEAN Health and Safety Manager
Earth Tech, Inc., Long Beach

Date: 3/22/2002

PAGE NO. ii

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SIGNATURE PAGE

By signing below, the undersigned acknowledges that he/she has read and reviewed the Earth Tech Health and Safety Plan for the Pre-Design Investigation for Operable Unit 2C, Landfill Sites 3 and 5, Former MCAS El Toro, California, as well as the applicable portions of the Earth Tech Field Health and Safety Manual. Undersigned also acknowledges that he/she has been instructed in the contents of these documents, understands the information presented that pertains to the specified work, and will comply with the provisions contained therein.

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PAGE NO. iv

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CONTENTS

APPROVAL PAGE	i
SIGNATURE PAGE	iii
ACRONYMS AND ABBREVIATIONS	ix
1. INTRODUCTION	1-1
1.1 Health and Safety Policy Statement	1-1
1.2 Classification of Activities	1-1
1.3 Regulatory Requirements	1-1
2. MANAGEMENT OF HEALTH AND SAFETY RESPONSIBILITIES	2-1
2.1 CLEAN Program Manager (Mr. Ken Vinson, P.E.)	2-1
2.2 CLEAN Health and Safety Manager (Mr. Robert Poll, CIH, CSP)	2-1
2.3 CTO Manager (Mr. Crispin Wanyoike, P.E.)	2-1
2.4 Field Manager (Rod Lazo)	2-2
2.5 Site Safety Officer (Rod Lazo)	2-2
2.6 Subcontractors (TBD)	2-3
2.7 Onsite Personnel and Visitors	2-3
3. SUMMARY OF SITE CONDITIONS AND PLANNED WORK ACTIVITIES	3-1
3.1 Site History and Current Conditions	3-1
3.2 Previous Sampling Investigations	3-1
3.3 Scope of Work	3-2
4. GENERAL HEALTH AND SAFETY PROCEDURES	4-1
4.1 Non-HAZWOPER Requirements	4-1
4.2 HAZWOPER Requirements	4-1
4.2.1 Medical Screening And Health Surveillance	4-1
4.2.2 HAZWOPER Training Requirements	4-2
4.2.3 Visitor Clearances	4-2
4.3 On-Site Training Procedures	4-2
4.3.1 Initial Orientation Training	4-2
4.3.2 Tailgate Safety Briefings	4-3
4.3.3 Hazard Communication Training	4-3
4.4 Housekeeping	4-3
4.5 General Site Safety Rules	4-3
4.5.1 Smoking, Eating, and Drinking	4-4
4.5.2 Personal Hygiene	4-4
4.5.3 Buddy System	4-4
4.5.4 Lighting	4-4
4.6 Controlled Work Areas	4-4
4.6.1 Work Area Control Records	4-5
4.7 Drum Handling	4-5
4.8 Injury Reporting	4-6
5. HAZARD ASSESSMENT	5-1
5.1 Specification of Work Tasks	5-1
5.1.1 Unanticipated Work Activities	5-1

5.2	Suspected Environmental Contaminants	5-1
5.2.1	Petroleum Hydrocarbon Fuels	5-2
5.2.2	BTEX	5-2
5.2.3	Solvents	5-3
5.2.4	Assessment of Hazards	5-5
5.3	Radioactive Materials	5-5
6.	ACTIVITY-SPECIFIC HEALTH AND SAFETY PROCEDURES	6-1
6.1	Slips, Trips, Falls, and Protruding Objects	6-1
6.2	Hazardous Noise Environments	6-1
6.3	Heavy Equipment Operation	6-1
6.4	Excavation Safety	6-2
6.4.1	Competent Person	6-2
6.4.2	Operating Safety Guidelines	6-2
6.5	Underground Utilities	6-3
6.6	Chemical Exposure Monitoring Procedures	6-3
6.6.1	Monitoring Instrumentation	6-3
6.6.2	Monitoring Procedures – HSA Drilling Activities	6-4
6.6.3	Monitoring Procedures – Landfill Delineation Activities	6-4
6.7	Radiological Monitoring	6-4
7.	PERSONAL PROTECTIVE EQUIPMENT AND DECONTAMINATION REQUIREMENTS	7-1
7.1	Personal Protective Equipment Requirements	7-1
7.1.1	General	7-1
7.1.2	HAZWOPER PPE Ensembles	7-2
7.2	Decontamination Activities	7-4
7.2.1	Personnel Decontamination	7-4
7.2.2	Equipment Decontamination	7-6
7.2.3	Disposal Of Decontamination Wastes	7-6
8.	EMERGENCY CONTINGENCY PLAN	8-1
8.1	Responsibilities	8-1
8.1.1	Site Safety Officer (SSO)	8-1
8.1.2	Other Onsite Personnel	8-1
8.2	Emergency Equipment	8-1
8.2.1	First Aid Kit	8-1
8.2.2	Fire Extinguisher	8-2
8.2.3	Eyewash Units	8-2
8.3	Response Actions—Medical Emergencies	8-2
8.3.1	Medical Assistance	8-3
8.4	Response Actions—Catastrophic Events	8-3
8.5	Response Actions—Safety Equipment Problems	8-3
9.	REFERENCES	9-1

ATTACHMENTS

- A Health and Safety Forms
- B General Safety Rules for Subcontractors
- C Drill Rig Safety Guidelines
- D Heavy Equipment Certification
- E Trenching/Excavation Checklist
- F Task Hazard Analyses
- G Radiation and its Health Effects

FIGURES

8-1	<u>Hospital Route Map</u>	8-5
-----	---------------------------	-----

TABLES

6-1	<u>Air Monitoring Instrumentation</u>	6-3
6-2	<u>Trenching/HSA Drilling Procedure Action Levels</u>	6-4
6-3	<u>Radiological Monitoring Levels</u>	6-5
8-1	<u>How to Respond to Medical Emergencies</u>	8-2
8-2	<u>Emergency Telephone Numbers</u>	8-4

PAGE NO. viii

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ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
bgs	below ground surface
CCR	California Code of Regulations
CIH	Certified Industrial Hygienist
CLEAN	Comprehensive Long-Term Environmental Action Navy
CNS	central nervous system
CRZ	Contamination Reduction Zone
CSIR	Contractor Significant Incident Report
CSP	Certified Safety Professional
CTO	Contract Task Order
dBA	decibels (A-weighted scale)
DoN	Department of the Navy
Earth Tech	Earth Tech, Inc.
ES&H	Environmental, Safety and Health
FM	field manager
H&SM	health and safety manager
H&SP	health and safety professional
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSA	hollow-stem auger
HSP	health and safety plan
IDW	investigation-derived waste
MCAS	Marine Corps Air Station
mg/kg	milligrams per kilogram
mg/m ³	milligram per cubic meter
OSHA	Occupational Safety and Health Administration
PACDIVFACENGCOM	Pacific Division, Naval Facilities Engineering Command
PAH	polynuclear aromatic hydrocarbon
P.E.	Professional Engineer
PEL	permissible exposure limit
PH	Petroleum hydrocarbons
PPE	personal protective equipment
ppm	parts per million
SSO	Site Safety Officer
SWDIV	Southwest Division, Naval Facilities Engineering Command
THA	task hazard analysis
TLV	threshold limit value
U.S.	United States
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

1. INTRODUCTION

The provisions of this Draft Health and Safety Plan (HSP) are mandatory for all Earth Tech personnel involved in the performance for the Pre-Design Investigation for Operable Unit (OU) 2C, Landfill Sites 3 and 5, Former Marine Corps Air Station (MCAS) El Toro California. This HSP also provides the specifications for the minimum acceptable requirements for all subcontractor organizations, and notification of the chemical and physical hazards known to be associated with the Earth Tech-managed activities addressed in this document.

Operational changes to this HSP that could affect the health or safety of personnel, the community, or the environment will not be made without prior approval of the Earth Tech Contract Task Order (CTO) Manager and the cognizant Earth Tech Health and Safety Professional (H&SP). In the event of a conflict between this HSP and federal, state, or local regulations, the most stringent will apply.

This HSP was prepared by Earth Tech, Inc. (Earth Tech) on behalf of the United States (U.S.) Department of the Navy (DoN), Southwest Division, Naval Facilities Engineering Command (SWDIV), as authorized by the U.S. Navy, Pacific Division, Naval Facilities Engineering Command (PACNAVFACENGCOM) under CTO number 0078 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) II program, contract number N62742-94-D-0048.

1.1 HEALTH AND SAFETY POLICY STATEMENT

It is the policy of Earth Tech to provide a safe and healthful work environment for all its employees. Earth Tech considers no phase of operations or administration to be of greater importance than injury and illness prevention. Safety takes precedence over expediency or shortcuts. At Earth Tech, we believe every accident and every injury is avoidable. We will take every reasonable step to reduce the possibility of injury, illness, or accident.

This HSP presents procedures to be employed during all onsite work activities. The practices and procedures presented in this HSP are mandatory for all Earth Tech employees (and subcontractors) while engaged in work operations at the site. Earth Tech also requires that all visitors to areas under its control abide by these procedures.

1.2 CLASSIFICATION OF ACTIVITIES

The work activities addressed in Section 3.3 are considered to be Hazardous Waste Operations, as defined in Title 8 California Code of Regulations (8 CCR) §5192 (a). Therefore, all personnel participating in this work must be qualified as Hazardous Waste Operations and Emergency Response (HAZWOPER) workers (see Section 4.1).

1.3 REGULATORY REQUIREMENTS

This HSP complies with applicable U.S. Department of Labor Occupational Safety and Health Administration (OSHA), California Occupational Safety and Health Administration (CAL/OSHA), and United States Environmental Protection Agency (USEPA) regulations. This plan follows the guidelines established by the regulatory agencies in the following documents:

- EM-385-1-1, U.S. Army Corps of Engineers and Safety and Health Requirements Manual, September 1996
- Navy/Marine Corps Installation Restoration Manual, Update 2000

- 8 CCR, Chapter 4, Subchapter 7 (General Industry Safety Orders), with particular attention to Section 5192, *Hazardous Waste Operations and Emergency Response*
- Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, National Institute of Occupational Safety and Health, NIOSH/OSHA/USCG/EPA. 85-115, October 1985
- Standard Operating Safety Guides, USEPA, November 1984

The requirements also conform to Earth Tech's Environmental, Safety and Health (ES&H) Program requirements.

2. MANAGEMENT OF HEALTH AND SAFETY RESPONSIBILITIES

Project/field-level management of health and safety requires that a management organization be established for each project. The organizational structure will be standardized for each Earth Tech project, and will consist of the following positions/responsibilities.

2.1 CLEAN PROGRAM MANAGER (MR. KEN VINSON, P.E.)

Earth Tech's CLEAN Program Manager is responsible for ensuring that CTO Managers are provided with adequate programmatic guidance, resources and support to enable safe planning and performance of field operations. Programmatic management and technical support aspects of this responsibility are delegated to the CLEAN Health and Safety Manager (H&SM); however, the Program Manager will retain ultimate responsibility for ensuring that work activities are performed safely.

2.2 CLEAN HEALTH AND SAFETY MANAGER (MR. ROBERT POLL, CIH, CSP)

The CLEAN H&SM oversees the technical and programmatic aspects of Earth Tech's Corporate and CLEAN Health and Safety Programs. In addition, the H&SM exercises CTO-specific duties, which include:

- Review and approval of this HSP
- Approval of the designated Site Safety Officer (SSO)
- Review of all personal exposure monitoring results
- Investigation of any reported unsafe acts or conditions.

For this project the H&SM will also serve as the assigned H&SP, and will provide the CTO with all H&S-related technical services and support. The H&SP will be the first point-of-contact for all CTO H&S matters.

2.3 CTO MANAGER (MR. CRISPIN WANYOIKE, P.E.)

The CTO Manager is responsible for coordinating with local Navy representatives, discipline managers and subcontractors to complete the project in accordance with requirements set forth in this HSP and/or other project H&S documentation. The CTO Manager has final responsibility for managing all aspects of the work operations, and is responsible to Earth Tech management for the safe performance and completion of the work activities. Specific safety-related duties include:

- Ensuring that an approved HSP is prepared that addresses all aspects of the work to be performed
- Ensuring that all personnel assigned to perform on-site activities meet the required qualifications
- Providing adequate resources and supplies to fulfill all work safety requirements
- Assigning the Field Manager (FM) and SSO, to provide on-site management of work activities
- Contacting the H&SP for guidance regarding any health and safety related matters.

2.4 FIELD MANAGER (ROD LAZO)

At each fieldwork site a FM will be assigned who manages all Earth Tech and subcontractor activities at the site, and is responsible for field implementation of the specified H&S requirements. This includes communicating site requirements to all personnel, observing that field supervisors and subcontractors enforce all provisions of the HSP/other H&S documentation, working with the SSO to implement all H&S performance elements, and consulting with the H&SP regarding any necessary changes to H&S requirements. Other responsibilities include:

- Reading and becoming familiar with the HSP
- Enforcing the HSP and other safety regulations
- Ensuring that no work is performed which is not properly addressed in this HSP (or approved supplemental guidance)
- Maintaining the presence of at least two qualified first aid providers on site at all times
- Contacting the H&SP for guidance regarding any health and safety related matters.

The FM is required to have completed an 8-hour HAZWOPER Supervisor Training Course in accordance with 8 CCR §5192 (e)(4).

2.5 SITE SAFETY OFFICER (ROD LAZO)

The FM or designated alternate (Imelda Morales) will serve as the SSO, and will be responsible for the execution of the routine on-site duties for health and safety, with assistance and direction from the designated H&SP. The responsibilities of the SSO include:

- Conducting periodic safety reviews of the project site and project documentation
- Performing regular and frequent site inspections to identify hazards and observe employees at work
- Stopping work, as required, to maintain personal and environmental health and safety
- Determining emergency evacuation routes, establishing and posting local emergency telephone numbers, and arranging emergency transportation
- Ensuring that all site personnel and visitors have received the proper training and medical clearance prior to entering the site
- Establishing any necessary controlled work areas (as designated in this HSP or other H&S documentation)
- Presenting tailgate safety meetings and maintaining attendance logs and records
- Discussing potential health and safety hazards with the FM, H&SP and the CTO Manager
- Implementing air monitoring according to directives in this HSP or other H&S documentation and forwarding all employee exposure monitoring information to the H&SP to enable the exposure notification

- Implementing the field elements of the Earth Tech Respiratory Protection Program
- Maintaining decontamination procedures that meet established criteria.

The SSO is required to have completed an 8-hour HAZWOPER Supervisor Training Course in accordance with 8 CCR §5192 (e)(4).

2.6 SUBCONTRACTORS (TBD)

Each Earth Tech subcontractor is responsible for assigning specific work tasks to their employees. Each subcontractor's management will provide qualified employees and allocate sufficient time, materials and equipment to safely complete assigned tasks. In particular, each subcontractor is responsible for equipping its personnel with any required personnel protective equipment.

Earth Tech considers each subcontractor to be an expert in all aspects of the work operations for which they are tasked to provide, and each subcontractor is responsible for compliance with those regulatory requirements, which pertain to those services. Each subcontractor is expected to perform its operations in accordance with its own unique safety policies and procedures, to ensure that hazards associated with the performance of the work activities are properly controlled. Copies of any required safety documentation for a subcontractor's work activities will be provided to Earth Tech for review prior to the start of on-site activities, if required. Operators of the direct push rig will be required to supply copies of the Hollow Stem Auger (HSA) Rig Certification form as required in Attachment C. In the event that subcontractor procedures/requirements conflict with requirements specified in this HSP, the more stringent guidance will be adopted.

Hazards not listed in this HSP but known to any subcontractor, or known to be associated with a subcontractor's services, must be identified and addressed to the Earth Tech CTO Manager or the FM prior to beginning work operations. The FM or authorized representative has the authority to halt any subcontractor operations, and to remove any subcontractor or subcontractor employee from the site for failure to comply with established health and safety procedures or for operating in an unsafe manner.

Attachment B provides Earth Tech's general subcontractor safety rules, which will be observed by all subcontractor organizations.

2.7 ONSITE PERSONNEL AND VISITORS

Each person (Earth Tech or subcontractor employee) is responsible for his/her own health and safety, for completing assigned tasks in a safe manner, and for reporting any unsafe acts or conditions to his/her supervisor and/or the FM/SSO. All personnel are responsible for continuous adherence to the specified health and safety procedures during the performance of their work. No person may work in a manner that conflict with the letter or intent of safety and environmental precautions expressed in these procedures. After due warnings, Earth Tech will dismiss from the work site any person who violates safety procedures. Earth Tech employees are subject to progressive discipline and may be terminated for blatant or continued violations.

All personnel working for Earth Tech and its subcontractors are required to read and acknowledge their understanding of the HSP and any other applicable H&S documentation. All visitors to controlled work areas of any project site must likewise read and acknowledge their understanding of the applicable H&S requirements. All personnel are expected to abide by all written H&S requirements and any supplementary instructions communicated by the FM/SSO, and cooperate with

supervisory personnel to ensure a safe and healthful work site. Site personnel are required to report immediately any of the following to the FM:

- Accidents and injuries, no matter how minor
- Unexpected or uncontrolled releases of any hazardous substances
- Any symptoms of exposure to a hazardous substance
- Any unsafe or malfunctioning equipment
- Any changes in site conditions, which may affect the health or safety of project personnel.

3. SUMMARY OF SITE CONDITIONS AND PLANNED WORK ACTIVITIES

The following is a summary of the known conditions and planned work operations for OU 2C, Landfill Sites 3 and 5. A more complete description of the site is provided in Sections 1.1.1 and 1.1.2 of the Work Plan. Greater detail concerning planned work activities can be found in Appendix A, Section A-1 of the Work Plan.

3.1 SITE HISTORY AND CURRENT CONDITIONS

The Former MCAS El Toro is located in a semi-urban, agricultural area of southern California, approximately 8 miles south of Santa Ana and 12 miles northeast of Laguna Beach. Land use around the MCAS included commercial, light industrial, and residential. The landfill Sites 3 and 5 are located within OU 2C of the Former MCAS El Toro and have been both closed around late 1950s to early 1960s. MCAS El Toro closed on July 2, 1999, as part of the Base Realignment and Closure Act.

Site 3 is located in the eastern portion and encompasses 11 acres. It is located between Irvine Blvd and North Marine Way. Site 3 landfill was used as a cut-and-fill disposal facility, which contains a variety of materials disposed at assorted locations within the landfill. It was speculated to contain all wastes generated on the Station, which includes metals, incinerator ash, solvents, paint residues, hydraulic fluids, engine coolants, construction debris, oily wastes, municipal solid waste, and various inert solid wastes (Earth Tech 2002b).

Site 5 is located in the eastern portion on the Tustin Plain near the foothills of Santa Ana Mountains, approximately 300 feet northwest of Borrego Canyon Wash. Site 5 was used as a cut-and-fill disposal facility. Wastes at Site 5 consisted mostly of burned wastes, municipal solid waste, cleaning fluids, scrap metals, paint residues, and unspecified fuels, oils, and solvents. The site also consists of two square cells approximately 240 feet on each side where investigation-derived waste (IDW) soil from Phase I and II remedial investigation activities was stored and covered with plastic tarps. The IDW soil was spread and graded across the top of the landfill trench in 1997. APHO 46 and MSCR2 are sites that are contiguous and overlap with Site 5. APHO 46 is an "aerial photograph anomaly" identified during a survey. MSCR2 is designated as a "miscellaneous refuse" site, and speculated to be used as landfill. APHO 46 and MSCR2 are likely to consist of non-hazardous construction debris, including concrete and metallic debris.

3.2 PREVIOUS SAMPLING INVESTIGATIONS

Soil sampling activities conducted at OU 2C indicated the presence of petroleum hydrocarbons and volatile organic compounds at above background concentrations:

- Petroleum hydrocarbons [PHs (primarily diesel range)], up to several hundred parts per million (ppm)
- Volatile organic compounds [VOCs (i.e., solvents and benzene)], up to several hundred ppm

Based on previous site investigation activities, no specific radiological impacts have been noted. However, on-site radiological screening will be conducted for investigation activities when needed. No other significant environmental contaminants (e.g., SVOCs, pesticides/herbicides, heavy metals, and radionuclides) were detected in other areas of sampling (e.g., air, soil vapor, sediment, groundwater, and surface-water).

Earth Tech's current work activities are intended to collect data as part of pre-design investigation for Landfill Sites 3 and 5, and characterize portions of APHO 46 and MSCR2, which were not previously investigated.

3.3 SCOPE OF WORK

Earth Tech will perform exploratory trenching and sampling activities at Landfill Sites 3 and 5, APHO 46, and MSCR2 as part of pre-design investigation. Sample collection activities will include the following:

1. Subsurface clearance
2. Excavation/trench activities
3. Subsurface soil sampling
4. Perimeter vapor well installation
5. Perimeter vapor well sampling

The investigation will last approximately 6 weeks and will include:

Subsurface clearance: Personnel will perform an evaluation of records prior to the establishment of preliminary locations of trenches. This will be performed prior to excavation or sampling. Only a geophysical survey will be conducted in the MSCR2 site.

Excavation/trench activities: Personnel will excavate a 200 ft wide by 15ft deep trench (maximum dimensions) to confirm lateral landfill delineation at Sites 3 and 5. The trench will be excavated using a backhoe. A PID or FID will be used to screen excavated soil for VOCs or PHs, and used in trenches to monitor and detect any vapors. From the APHO 46 and MSCR2 site, shallow depths of debris/soil (approximately 1 foot) will be excavated using a backhoe and filled in Landfill Site 5. A radiological survey will also be performed on the excavated soil. There will be no trench entry involved.

Subsurface soil sampling: Up to 7 samples will be collected at Site 3 and up to 4 samples will be collected at Site 5 using a shovel/bucket collected from the trench for geotechnical analysis. In the case of APHO 46, confirmatory soil samples will be collected using a backhoe at the bottom and along the sides of the excavation. Soil samples from APHO 46 will be collected following excavation of debris to confirm that no residual contamination exists.

Perimeter vapor well installation: Six boreholes at Site 3 and four boreholes at Site 5 will be drilled using a hollow-stem auger (HSA) to total depth at least 5 feet above the seasonal groundwater table. Polyvinyl chloride (PVC) Schedule 40 casing will be used. Monitoring wells will be completed above ground using an 8-inch diameter lockable anodized aluminum well monument, with a concrete pad around the monument.

Perimeter vapor sampling: Samples will be collected using a vacuum pump and Tedlar bag for total VOC fixed gases.

The following additional tasks will also be performed as necessary in support of the investigation efforts:

Equipment Decontamination: Earth Tech and subcontractor personnel will perform decontamination of vehicles and equipment used to perform work within controlled work areas.

Investigation-Derived Waste (IDW) Management: IDW will be collected and categorized as non-hazardous or hazardous. Potentially hazardous IDW (drill cuttings, purge water, decontamination fluids, etc.) will be tested and disposed of within 90 calendar days of completing the field activities. Non-hazardous IDW (normal trash) will be disposed of in a timely fashion following fieldwork.

4. GENERAL HEALTH AND SAFETY PROCEDURES

The work activities addressed in Section 3.3 are considered to be Hazardous Waste Operations, as defined in 8 CCR §5192 (a). Therefore, all personnel participating in this work must be qualified as HAZWOPER workers.

4.1 NON-HAZWOPER REQUIREMENTS

Prior to initiating remediation activities, Earth Tech will perform the following site preparation activities. All of these activities are classified as non-HAZWOPER and hence, will not need to meet the provisions established in 8 CCR §5192 (e)(2) and (e)(3) (40-hour or 24-hour initial training):

- Subsurface clearance
- Excavation/trench activities
- Subsurface soil sampling
- Perimeter vapor well installation
- Perimeter vapor well sampling

4.2 HAZWOPER REQUIREMENTS

Personnel performing designated HAZWOPER activities (see Section 5.1) must meet the following requirements.

4.2.1 Medical Screening And Health Surveillance

In accordance with Earth Tech Health and Safety Policy HS601, *Medical Surveillance*, personnel performing HAZWOPER activities (and visitors entering any HAZWOPER work area) will have completed a physical exam in accordance with the requirements of 8 CCR §5192 (f). The examining physician will specify exam procedures and tests.

The results of medical examinations are to be evaluated by a physician specializing in occupational medicine. The medical evaluation must include a judgment of the employee's ability to use respiratory protective equipment and to participate in hazardous waste site activities. The examining physician must document his evaluation/recommendations in writing. Restrictions of onsite activities may be required for personnel with certain medical conditions, which could be aggravated, by chemical exposure or physical demands at the site. Each employee is responsible for notifying the H&SP of physical or medical restrictions. The H&SP will then ensure that project management observes and enforces the restrictions. A copy of each person's written medical evaluation will be made available for review following a request from the H&SP. Employees who have not received a medical examination within 12 months (365 days) of their previous medical exam will be required to immediately obtain an appropriate medical exam and provide a copy of the medical evaluation to the H&SP for review prior to starting work on the project.

Personnel who are not routinely exposed to site hazards may be waived from the annual medical examination requirement by the H&SP, provided that they meet the following:

- Medical examinations are received on a frequency determined by the examining physician, but not to exceed every two (2) years

- Site activities performed by the exempted personnel do not entail exposure to contaminants in excess of the permissible exposure limits or other exposure limitations as outlined in this HSP.

4.2.2 HAZWOPER Training Requirements

In compliance with Earth Tech Health and Safety Policy HS301, *HAZWOPER Training and Refresher*, all Earth Tech personnel involved with site activities (or site visitors) must successfully complete training meeting the provisions established in 8 CCR §5192 (e)(2) and (e)(3) (40-hour or 24-hour initial training). All personnel will also receive annual refresher training in accordance with 8 CCR §5192 (e)(8), and must have completed the most recent training course within the previous 365 days.

Work supervisors will also receive an additional required 8 hours of training addressing supervisor responsibilities and obligations in maintaining an effective health and safety program in accordance with 8 CCR §5192 (e)(4).

4.2.3 Visitor Clearances

Visitors to any HAZWOPER controlled-work area must comply with the health and safety requirements of this HSP, and demonstrate an acceptable need for entry into the work area. All visitors desiring to enter any controlled work area must observe the following procedures:

1. A written confirmation must be received by Earth Tech documenting that each of the visitors has received the proper training and medical monitoring required by this HSP. Verbal confirmation can be considered acceptable provided an officer or other authorized representative of the visitor's organization makes such confirmation.
2. Each visitor will be briefed on the hazards associated with the site activities being performed and acknowledge receipt of this briefing by signing the appropriate tailgate safety briefing form.

If the site visitor requires entry to any Exclusion Zone, but does not comply with the above requirements, all work activities within the Exclusion Zone must be suspended and monitoring using direct reading instruments must indicate that no airborne contaminant concentrations are present which exceed the established background levels. Until these requirements have been met entry will not be permitted.

4.3 ON-SITE TRAINING PROCEDURES

The following training procedures will be accomplished for all operational activities.

4.3.1 Initial Orientation Training

All on-site personnel will be trained about potential hazards at the site, and exposure prevention or control measures. Field personnel will be:

1. Instructed on the contents of applicable portions of this plan.
2. Made aware of task-specific physical hazards and other hazards, which may be encountered during site work (see Attachment D).

3. Informed about the potential routes of exposure, protective clothing, precautionary measures, and symptoms or signs of chemical exposure, and heat stress.
4. Made aware of fire prevention measures, fire extinguishment methods, and evacuation procedures.

The PM shall ensure that this training is provided to each person prior to his/her entry into any controlled area. All site-specific training should be documented on the *Tailgate Safety Briefing Sign-in Log*, a copy of which is found in Attachment A.

4.3.2 Tailgate Safety Briefings

A tailgate safety briefing will be conducted at the start of each workday. The SSO will conduct the tailgate safety briefings, and will review and discuss the health and safety issues associated with the day's planned work activities, problems encountered, and modifications to existing procedures. Documentation of the tailgate safety briefings will be accomplished by using the *Tailgate Safety Briefing Sign-in Log*. The SSO will maintain copies of all tailgate safety briefing sign-in logs in the project files. All field personnel associated with each day's project activities are required to attend these meetings.

4.3.3 Hazard Communication Training

Section 5.2 provides information concerning the materials that may be encountered as environmental contaminants during the work activities. In addition, any organization wishing to bring any hazardous material onto any Earth Tech-controlled work site must first provide a copy of the item's Material Safety Data Sheet (MSDS) to the SSO for approval and filing (the SSO will maintain copies of all MSDSs on site). For locally obtained products MSDSs may not be available, in which case some alternate form of product hazard documentation will be acceptable. In accordance with the requirements of Earth Tech Health and Safety Procedure HS401, *Hazard Communication*, all personnel shall be briefed on the hazards of any chemical product they use, and shall be aware of and have access to all MSDSs.

All containers on site shall be properly labeled to indicate their contents. Labeling on any containers not intended for single-day, individual use shall contain additional information indicating potential health and safety hazards (flammability, reactivity, etc.).

4.4 HOUSEKEEPING

During site activities, work areas will be continuously policed for identification of excess trash and unnecessary debris. Excess debris and trash will be collected and stored in an appropriate container (e.g., plastic trash bags, garbage can, roll-off bin) prior to disposal. At no time will debris or trash be intermingled with waste personal protective equipment (PPE) or contaminated materials. Anyone observed throwing contaminated material or PPE away with municipal wastes will be removed from the site.

4.5 GENERAL SITE SAFETY RULES

All personnel must abide by the following general safety rules.

4.5.1 Smoking, Eating, and Drinking

Smoking, eating, and drinking will not be permitted in controlled work areas. Field workers will first wash hands and face immediately after leaving controlled work areas (and always prior to eating or drinking). Consumption of alcoholic beverages is prohibited at any Earth Tech site.

4.5.2 Personal Hygiene

In accordance with EM 385-1-1 Section 2, the following requirements will be observed:

Water Supply: A water supply meeting the following requirements will be utilized:

Potable Water - An adequate supply of potable water will be available for field personnel consumption and use in cleaning activities. Potable water used for drinking can be provided in the form of water bottles, canteens, water coolers, or drinking fountains. Individual use cups will be provided as well as adequate disposal containers. Potable water containers will be properly identified in order to distinguish them from non-potable water sources

Non-Potable Water - Non-potable water cannot be used for drinking or washing purposes, but may be used for non-hygiene-related activities. All containers of non-potable water will be marked with a label stating:

**Non-Potable Water
Not Intended for Drinking Water Consumption**

Toilet Facilities: If access to permanent toilet facilities is not available, a portable toilet facility will be provided on the work site. Portable toilets must include hand-washing capabilities (hand wipes are adequate to meet this need).

Washing Facilities: Employees will be provided with washing facilities (e.g., buckets with water and Alconox) at the work site. Personnel will be required to clean hands and face using water and hand soap (or similar substance) prior to breaks and at the end of daily work activities.

4.5.3 Buddy System

All field personnel shall use the buddy system when working within any controlled work area. Personnel belonging to another organization onsite can serve as "buddies" for Earth Tech personnel. Under no circumstances shall an Earth Tech employee be present alone in a controlled work area.

4.5.4 Lighting

At a minimum, all portions of the work area will be sufficiently lit so that all surfaces are illuminated at 10 foot candles or greater. Since work will occur during daylight hours the need for supplemental lighting is not anticipated in meeting this requirement.

4.6 CONTROLLED WORK AREAS

The area surrounding each sampling location presents hazards related to the physical hazards associated with the work procedures. To minimize hazards to personnel not directly involved in sampling procedures a controlled work area will be established. The extent of each area will be sufficient to ensure that personnel located at/beyond its boundaries will not be affected in any substantial way by hazards associated with sample collection activities. To meet this requirement, the following minimum distances will be used:

- **Drilling (HSA).** Determine the mast height of the drill rig. This height will be cleared, if practical, in all directions from the bore hole location and designated as the exclusion zone. The cleared area will be sufficient to accommodate movement of necessary equipment and the stockpiling of spoils piles.
- **Soil Sampling.** Personnel will safely collect and handle surface/subsurface soil samples contaminated with low-to-moderate concentrations (expected <5,000 parts per million [ppm]) of hydrocarbon fuels, where an excavator, backhoe or appropriate device is used to retrieve samples remotely.
- **Landfill Delineation (Trenching).** Excavated materials will be stored and retained at least 2 feet from the edge of the excavation (Note: this procedure should be observed even when excavation/trench entry will not occur). The excavation will not exceed 20 feet in depth. All ladders used in excavation operations will be in accordance with the requirements of 8 CCR §1675 through 1678. Excavations will be inspected daily, or more often as conditions warrant, by a competent person to ensure that changes in temperature, precipitation, shallow groundwater, overburden, nearby building weight, vibrations, or nearby equipment operation has not caused weakening of sides, faces, and flows. Requirements pertaining to excavation safety can be found in Section 6.4.
- **Decontamination.** Ten feet will be cleared in all directions from the decontamination location, where practical, for large efforts (e.g., vehicle and drilling equipment) conducted at a decontamination pad. For personal and small parts decontamination conducted at the work location, keep decontamination activities within the applicable Exclusion or Contamination Reduction Zone (CRZ) established for that operation.

Access to each Exclusion Zone will be accomplished through a single entry point, which shall also serve as the location of the CRZ where personal and equipment decontamination will occur. The CRZ, which must be large enough to encompass decontamination activities and prevent unauthorized personnel from approaching closer than is safe, shall be located inside the fence such that it allows direct and sole access in/out of the gated entry point.

All personnel should be alert to prevent unauthorized, accidental entrance into controlled-access areas (the Exclusion Zone and CRZ). If such an entry should occur, the trespasser should be immediately escorted outside the area, or all HAZWOPER-related work must cease. All personnel, equipment and supplies, which enter controlled-access areas must be decontaminated or containerized as waste prior to leaving (through the CRZ only).

4.6.1 Work Area Control Records

The SSO will record the identities of all personnel working or entering the Exclusion Zone each day.

4.7 DRUM HANDLING

The handling of all containers used for storage of materials will be performed in accordance with the requirements of Earth Tech Health and Safety Procedure HS 724, *Handling of Drums and other Large Containers*. Where containers of capacity greater than 10 gallons are used for containerizing chemical products or waste materials, handling of the containers will be accomplished in accordance with the following:

- When not in use, drums/containers will be covered with tight fitting lids
- At the conclusion of each work shift all drums/containers will be placed in a designated waste storage area. This area will be properly marked and secured

- Mechanical or powered drum handling equipment will be used to move drums/containers. Manual handling of the drums leads to musculo-skeletal injuries and will be avoided to the maximum extent possible.

If sampling of drums for waste characterization purposes is required, it will be accomplished in a manner to minimize potential for skin contact. Handling of potentially contaminated soils and groundwater presents the risk of contact with hazardous substances. In order to provide protection against skin contact with contaminated materials, all sample collection activities will be performed using Modified Level D protective equipment ensembles. Specified personnel decontamination procedures will also be observed.

4.8 INJURY REPORTING

Any workplace accident will be promptly reported to the SSO and the FM.

If any Earth Tech employee requires medical treatment Earth Tech's Workers Compensation Adjuster, Sedgwick CMS (877-261-8926) will be notified. The CTO Manager will initiate a written report, using the *Supervisor's Report of Incident* form (found in Attachment A). The CTO Manager will complete the first three sections of this form, and forward to the H&SP within 24 hours of the incident.

If any employee of a subcontractor is injured, documentation of the incident will be accomplished in accordance with the subcontractor's procedures, however copies of all documentation (which at a minimum must include the OSHA Form 101 or equivalent) must be provided to the SSO within 24 hours after the accident has occurred.

The H&SP will review the documentation, and will assist in the performance of any necessary accident investigation or other follow-up. The CTO Manager will ensure that the recommendations resulting from any investigation are implemented without delay. Additionally, mishap reports must be submitted to the CLEAN Contracting Officer according to the following schedule:

1. **Tier One:** Serious Contractor Mishap, any mishap involving a fatality or the hospitalization of three or more workers, or resulting in property damage exceeding \$200,000 in value. The H&SP will provide immediate telephone notification to the Contracting Officer; the Contractor Significant Incident Report (CSIR)-1 must be submitted to the Contracting Officer within 8 hours of the mishap.
2. **Tier Two:** Significant Contractor Mishap, falls of 4 feet or more, electrical, confined space, diving, crane, trenching entrapment, hazardous material, hazardous waste, and equipment mishaps which involve a lost-time injury or property damage of \$10,000 or more in value, the CSIR-1 must be submitted to the Contracting Officer within 24 hours of the mishap.
3. **Tier Three:** General Contractor Mishap, any OSHA recordable mishap not meeting the definitions of tier one-serious or tier two-significant contractor mishap, the CSIR-1 must be submitted to the Contracting Officer within 5 working days of the mishap.

Following any on-site injury or accident the H&SP will review the available documentation, and will assist in the performance of any necessary accident investigation or other follow-up. The CTO Manager will ensure that the recommendations resulting from any investigation are implemented without delay.

5. HAZARD ASSESSMENT

For this project, Earth Tech will perform primarily sampling tasks. Performance of these tasks can expose sample collection personnel to a variety of hazards due to the operational activities, physical conditions of the work locations, and the potential presence of environmental contaminants (see Section 3.1.1).

5.1 SPECIFICATION OF WORK TASKS

The following is a listing of the work tasks to be performed during the sampling activities. A task hazard analysis (THA) has been prepared for each task, which specifies the major performance steps, identifies the related hazards and applicable safety procedures, and specifies any additional requirements (e.g., monitoring procedures). All THAs can be found in Attachment F:

1. Subsurface clearance
2. Excavation/trench activities
3. Subsurface soil sampling
4. Perimeter vapor well installation
5. Perimeter vapor well sampling

5.1.1 Unanticipated Work Activities

Where work activities are identified which are not addressed in this HSP, appropriate safety documentation and procedures will be implemented. Prior to initiation of work activities any subcontractor organization tasked with performance of such work will submit a work procedure document, which presents appropriate safety procedures applicable to the specific work activities to be undertaken. Submitted safety procedures will be reviewed by the H&SP for adequacy and compliance with applicable regulatory requirements and the requirements presented in this HSP. Work will not be initiated until this review is completed and any identified deficiencies corrected to the satisfaction of the H&SP.

The H&SP may issue an exemption to this requirement based on the nature of the work activities to be undertaken.

5.2 SUSPECTED ENVIRONMENTAL CONTAMINANTS

The information presented below is intended to inform site personnel about the expected hazards associated with known or suspected environmental contaminants. Hazards associated with the use of commercially available hazardous materials are addressed as part of worker hazard communication requirements (see Section 4.2.3).

Suspected environmental contaminants include:

- Petroleum hydrocarbons (PHs)
- Aromatic hydrocarbons (BTEX)
- Solvents

Anticipated environmental contaminants (i.e., SVOCs, herbicides/pesticides, heavy metals, and radionuclides) that site personnel may be exposed to while performing work activities onsite are described below. Should other contaminants be detected, the H&SP will update the information on hazards accordingly.

5.2.1 Petroleum Hydrocarbon Fuels

Petroleum hydrocarbon fuels include gasoline (leaded and unleaded), diesel, and jet fuel. Each is produced by refining various crude oil fractions. Because refining is primarily a distillation process, all petroleum fuels contain a mixture of hydrocarbon compounds (primarily in the aliphatic and aromatic families), additives, and agents introduced in final blending to improve performance, to clean/lubricate engine components, and to reduce emissions.

Aviation Gasoline/Gasoline. Gasoline is a complex mixture of hydrocarbons and additives, used primarily as a motor fuel. Gasoline possesses a moderate to high vapor pressure. The lower explosive limit for gasoline is 1.1 percent concentration in air. Fire and explosion can be significant in enclosed spaces where airborne concentrations may accumulate.

Chronic exposures or exposures to a high concentration of gasoline vapor may cause unconsciousness, coma, and possibly death from respiratory failure. Exposure to low concentrations of gasoline vapor may produce flushing of the face, slurred speech, and mental confusion. Gasoline is irritating to the skin. Prolonged contact may cause drying and dermatitis.

Gasoline components and additives can themselves present significant hazards. The aromatic compounds benzene, toluene, ethylbenzene, and total xylenes (BTEX) are the greatest concern for this study. Some additives used to control octane (e.g., methyl tertiary butyl ether—MTBE), oxygenation (e.g., alcohols and MTBE), and water-scavenging (e.g., ethylene glycol methyl ether—EGME) can also present significant hazards as a result of prolonged inhalation or skin exposure. In the past, tetra-ethyl and tetra-methyl lead, both of which have been identified as carcinogens that also present moderate skin contact hazards, were added to gasoline for anti-knock control.

Both the Cal/OSHA PEL and the ACGIH TLV for gasoline are 300 ppm. Inhalation exposure to gasoline (and its various constituents and additives) can be controlled through the use of air-purifying respirators equipped with organic vapor cartridges. The use of skin protection (e.g., chemical-resistant gloves, etc.) is required when handling gasoline-contaminated materials.

Jet Fuel. Jet fuel is a refined kerosene fuel with properties similar to diesel fuel. There are no established exposure standards from either OSHA or ACGIH for jet fuel. However, onsite action levels based on the potential presence of BTEX (particularly benzene) have been developed. Inhalation of these fuels (and their constituents) can be controlled through the use of air-purifying respirators equipped with organic vapor cartridges; though the need to use this PPE is not expected. The use of skin protection (e.g., chemical-resistant gloves, etc.) is required when handling fuel-contaminated materials.

5.2.2 BTEX

The aromatic compounds of BTEX are generally found together as significant components of petroleum fuels (e.g., diesel fuel). Due to their high vapor pressure and the range and severity of their health effects, they are considered to present the greatest hazard during site investigation operations.

Benzene. Benzene is a known human carcinogen. Prolonged skin contact with benzene or excessive inhalation of its vapor may cause headache, weakness, loss of appetite, and lassitude. Continued exposure can cause collapse, bronchitis, and pneumonia. The most important health hazards are cancer (leukemia), bone marrow effects, and injuries to the blood-forming tissue from chronic low-level exposure. The CAL/OSHA PEL is 1 ppm, with an action level of 0.5 ppm and a short-term exposure limit of 5.0 ppm. The ACGIH exposure guideline is 0.5 ppm.

Toluene. Exposure to vapors of toluene may cause irritation of the eyes, nose, upper respiratory tract, and skin. Exposure to 200 ppm for 8 hours causes mild fatigue, weakness, confusion, tearing, and a sensation of prickling, tingling, or creeping on the skin that has no objective cause. Exposure to higher concentrations may cause headache, nausea, dizziness, dilated pupils, and euphoria, and in severe cases may cause unconsciousness and death. The liquid is irritating to the eyes and the skin. Contact with the eyes may cause transient corneal damage, conjunctival irritation, and burns if not promptly removed. Repeated or prolonged contact with the skin may cause drying and cracking. Toluene may be absorbed through the skin in toxic amounts. Ingestion causes irritation of the gastrointestinal tract and may cause effects resembling those from inhalation of the vapor. Chronic overexposure to toluene may cause irreversible liver and kidney injury. The CAL/OSHA PEL is 50 ppm; the ACGIH TLV is 50 ppm.

Ethylbenzene. Ethylbenzene vapors are severely irritating to the eyes and the mucous membranes of the respiratory system. Sustained inhalation of excessive levels can cause depression of the CNS characterized by dizziness, headache, narcosis, and coma. Skin contact with liquid ethylbenzene causes irritation; dermatitis and defatting can also develop. The acute oral toxicity of ethylbenzene is low; however, ingestion of it poses a serious aspiration hazard. Aspirating even a small amount into the lungs can result in extensive edema (lungs filled with fluid) and hemorrhaging of the lung tissue. No systemic effects are suspected at the levels that produce pronounced, unignorable, disagreeable skin and eye irritation. The established PEL is set well below this intolerable level. The CAL/OSHA PEL and ACGIH TLV are both 100 ppm.

Xylene. Liquid xylene is a skin irritant and causes itching, dryness and defatting; prolonged contact may cause blistering. Inhaling xylenes can depress the CNS, and ingesting it can result in gastrointestinal disturbance and possibly hematemesis (vomiting blood). Effects on the eyes, kidneys, liver, lungs, and the CNS are also reported. Both the CAL/OSHA PEL and ACGIH TLV are 100 ppm.

5.2.3 Solvents

The widespread use of organic solvent compounds for a variety of cleaning and surface treating industrial applications has occurred for many decades. During that time, usage patterns have changed as better compounds have been identified. Costs have changed and/or knowledge concerning the hazards associated with particular solvents have prompted replacement with less hazardous alternatives. Therefore, while it is known that solvents have been employed at some of the POIs, there is no means for identifying, which solvents may be present as environmental contaminants. In addition, many types of solvents, especially chlorinated compounds, break down in the environment into several intermediate solvent compounds (e.g., TCE can form several isomers of dichloroethylene).

The following information addresses the solvents most commonly used in automotive and general maintenance activities. Should other solvent materials be identified, supplemental information can be provided to this HASP. However, since most solvents share similar hazards and modes of exposure (inhalation and skin contact), the work procedures, monitoring requirements and protective equipment already required should be adequate to address these situations.

Tetrachloroethylene (Perchloroethylene – PCE). PCE affects the central nervous system, causing uncoordination, headache, vertigo (loss of balance), light narcosis, dizziness, and unconsciousness. In extremely high concentrations death may occur. Various types of irritable effects have been attributed to PCE exposure. Some of the symptoms involved include: eye, nose, and throat irritation, indications of nausea and intestinal gas, and possible changes to both the liver and the kidneys. Skin exposure to PCE has not been seen to produce harmful effects in cases where the PCE was allowed to evaporate immediately after contact. However, in cases where skin was exposed to PCE frequently and for prolonged periods of time without evaporating, symptoms of dermatitis by defatting of the skin was evident. PCE is listed as an anticipated human carcinogen by the NTP. The CAL/OSHA PEL and the ACGIH TLV are 25 ppm with an ACGIH STEL of 100.

Carbon Tetrachloride. In the past, carbon tetrachloride saw extensive use as an industrial solvent; however, identification of less toxic alternatives has resulted in significantly reduced use. Like most other organic solvents, "carbon tet" can produce central nervous system (CNS) function depression due to acute exposure, with symptoms including headache, vertigo, mental confusion and nausea. Chronic exposure can result in liver and kidney damage, and carbon tet is a suspected human carcinogen. Exposure to carbon tet is highly synergistic with alcohol. Consumption of alcohol with exposure to carbon tet may cause a fatal interaction. The CAL/OSHA PEL for carbon tetrachloride is 2 ppm, while the ACGIH TLV is 5 ppm.

Methylene Ethyl Ketone (MEK). MEK exhibits properties similar to other organic solvents. Acute exposure may lead to CNS depression, causing symptoms such as confusion, lethargy, nausea, and headache. Chronic exposure can result in damage to the liver. Exposure routes of concern are inhalation and skin absorption; further, skin contact can lead to the formation of contact dermatitis. Both the CAL/OSHA PEL and ACGIH TLV are 200 ppm.

Stoddard Solvent. Stoddard solvent, also known as white mineral spirits, is a colorless, flammable liquid, with a kerosene-like odor. It is widely used as a general cleaning and degreasing agent. Stoddard solvent is produced through refining of light petroleum distillates, and is composed of various paraffins, naphthenes and alkylbenzenes, with a trace of benzene. The effects of exposure to Stoddard solvent resemble the effects seen with gasoline, and can include nausea, cough and pulmonary irritation with acute exposures, and liver and blood-forming organ damage due to chronic exposure. Skin contact can produce irritation, drying/scaling, and development of dermatitis.

Adequate protection against elevated airborne concentrations of Stoddard solvent can be provided by air purifying respirators using organic vapor cartridges. The use of chemically resistant gloves and clothing is necessary where there is the potential for skin contact. The CAL/OSHA PEL is 100 ppm, while the ACGIH TLV is 100 ppm.

1,1,1-Trichloroethane (TCA). TCA (also known as methyl chloroform) exhibits low oral toxicity. It can defat the exposed skin of workers and cause redness and scaling. Although TCA has a low systemic toxicity, it is an anesthetic capable of causing death if inhaled at concentrations of 14,000 ppm to 15,000 ppm. Fatalities that have occurred in poorly ventilated areas such as pits or tanks are attributed to anesthesia and/or sensitization of the myocardium to epinephrine. Quick and complete recovery is reported upon prompt removal of unconscious exposed persons from the area of exposure. The exposure standards are set to prevent initial anesthetic effects and/or objections to the odor. Both the CAL/OSHA PEL and the ACGIH TLV are 350 ppm, while the OSHA and ACGIH STELS are 450 ppm.

Trichloroethylene (TCE). Moderate exposures to TCE cause symptoms similar to those of alcohol inebriation. Higher concentrations cause narcotic effects. Ventricular fibrillation has been cited as the cause of death following heavy exposures. TCE-induced hepatocellular carcinomas have been

detected in mice during tests conducted by the National Cancer Institute. Organ systems affected by overexposure to TCE are the CNS (euphoria, analgesia, anesthesia), degeneration of the liver and kidneys, the lungs (tachypnea), heart (arrhythmia) and skin (irritation, vesication, and paralysis of fingers when immersed in liquid TCE). Contact with the liquid defats the skin, causing topical dermatitis. Certain people appear to experience synergistic effects from TCE exposure concomitant with exposure to caffeine, alcohol, and other drugs. Other reported symptoms of TCE exposure include abnormal fatigue, headache, irritability, gastric disturbances, and intolerance to alcohol. Both the CAL/OSHA PEL is 25 ppm while the ACGIH TLV is 50 ppm, the ACGIH STEL is set at 100 ppm.

5.2.4 Assessment of Hazards

There is the potential for occupational exposure to occur through two direct routes (inhalation and skin contact) and one indirect route (ingestion). Descriptions of exposure hazards and protective measures for each contaminant type can be found in Section 5.2.

Inhalation

With the exception of PHs, all suspected environmental contaminants possess very low vapor pressures. Air monitoring for airborne organic compounds will be conducted during intrusive activities. Inhalation of contaminated dusts can also occur, and real-time monitoring will be employed to ensure that level remain within acceptable limits.

Skin Contact

Contact with contaminated materials is likely during intrusive activities and collection/handling of environmental samples. However, protection against skin contact/absorption can be accomplished through the use of protective gloves/clothing (see Section 7.1).

Ingestion

Contact with contaminated materials is likely during intrusive activities and collection/handling of environmental samples. However, protection against exposure via ingestion can be accomplished by performance of proper decontamination procedures when exiting contaminated work areas (see Section 7.2.1).

5.3 RADIOACTIVE MATERIALS

Although radioactive materials were not detected in previous investigations, radiological survey instruments will be used at the sites during excavation, trench, and probe installation activities.

Normal disposal operations practices would likely have resulted in the intact disposal of these radioactive materials as part of municipal trash disposal. Thus it is anticipated that any radioactive materials encountered would consist of a source that is still part of the original devices/materials into which they were constructed.

Attachment G contains general information on the hazards of radiation and radioactive materials. However, intact devices do not present a significant hazard to personnel. Because of limited on-site activities, which will be performed by Earth Tech personnel, the presence of radioactive materials is not expected to present a significant exposure hazard.

6. ACTIVITY-SPECIFIC HEALTH AND SAFETY PROCEDURES

The THAs in Attachment D refer to the following safe work procedures.

6.1 SLIPS, TRIPS, FALLS, AND PROTRUDING OBJECTS

Hazards from protruding objects, careless movements, or placement of materials on paths or foot traffic areas present a problem with regard to slips, trips, falls, and puncture wounds. Personnel will use a reasonable amount of effort to ensure the prevention of such injuries.

6.2 HAZARDOUS NOISE ENVIRONMENTS

Working around large equipment often creates excessive noise. The effects of noise can include physical damage to the ear, pain, and temporary and/or permanent hearing loss. Workers can also be startled, annoyed, or distracted by noise during critical activities.

Earth Tech has compiled noise-monitoring data, which indicates that work locations within 25 feet of operating heavy equipment (drill rigs, earthworking equipment, etc.) can result in exposure to hazardous levels of noise [levels greater than 90 decibels (A-weighted scale) (dBA)]. Accordingly, all personnel are required to use hearing protection (ear plugs or ear muffs) within 25 feet to any operating piece of heavy equipment.

The H&SP may also monitor employee exposure to hazardous noise levels as part of Earth Tech's Hearing Conservation Program.

6.3 HEAVY EQUIPMENT OPERATION

The use of heavy earthworking machinery (excavator/backhoes, bulldozers, etc.) poses significant hazards if equipment is not maintained in good working order. In order to assure that all equipment used on site presents no unwarranted safety hazards, the owner/operator of each piece of heavy equipment must perform a safety evaluation and certification. Instructions and a copy of the submittal form can be found in Attachment C and D.

Vehicle Requirements

Certification: Earthmoving vehicles are required to comply with the design and performance requirements specified in 8 CCR §1592 - §1597.

Alarms: All earthworking equipment shall be equipped with the following:

1. Horn.
2. Audible back-up alarm.
3. Auxiliary lights if general lighting is less than 2 foot-candles.

Modifications: No modifications shall be made to any vehicle without written authorization from the manufacturer.

Worker Safety

Working around heavy equipment poses considerable hazards to pedestrian workers and operators of light vehicles. To minimize the hazards the following requirements will be observed:

1. Operators are responsible for the safe use of their equipment, and must be aware of the location of unprotected personnel at all times while operating this machinery to avoid serious accidents.
2. To improve visibility to operators all personnel working in an area where heavy equipment operations are on-going will wear a high-visibility traffic safety vest.

6.4 EXCAVATION SAFETY

6.4.1 Competent Person

The Project Manager will appoint a designated "competent person" (FM or SSO) to oversee excavation safety. This person must meet the following qualifications:

- Has sufficient experience to identify existing and predictable hazards in the excavation surroundings, or working conditions which are unsanitary, hazardous or dangerous to employees
- Must be a registered Professional Engineer (P.E.) in civil engineering, or
- Has completed a minimum of 6 hours of training in excavation safety which includes the following elements:
 - Soils classification and identification
 - Appropriate sloping/shoring methods
 - Shoring system types and construction
 - Operational safety practices
 - Inspection of excavations.

The designated competent person will be responsible for:

1. Performing a daily inspection of the excavation (to be documented on the *Trenching/Excavation Checklist* form in Attachment E).
2. Overseeing excavation operations to ensure that they conform to the requirements of 8 CCR §1541 and 8 CCR §1541.1, and the following operational safety guidelines.

6.4.2 Operating Safety Guidelines

The following safe operating guidelines will apply to excavations exceeding 4 feet in depth.

1. Excavated materials will be stored and retained at least 3 feet from the edge of the excavation.
2. Trees, boulders, and other surface encumbrances that create a hazard will be removed or made safe before excavation is begun.
3. Special precautions will be taken in sloping or shoring the sides of excavations adjacent to a previously backfilled excavation.
4. Except in hard rock, excavations below the level of the base of the footing of any foundation or retaining wall will not be permitted unless the wall is underpinned and all other precautions have been taken to ensure the stability of the adjacent walls.

5. Diversion ditches, dikes or other suitable means will be used to prevent water from entering an excavation and for drainage of the excavation.
6. When mobile equipment is used or allowed adjacent to excavations, stop logs or barricades will be installed. The grade will always be away from the excavation.
7. Dust conditions during excavation will be kept to a minimum. Wetting agents shall be used upon the direction of the FM.
8. Field personnel shall not enter any excavation, without specific direction, for any reason except to rescue injured individuals who have fallen into the excavated area.
9. All ladders used in excavation operations will be in accordance with the requirements of 8 CCR Sections 1675-1678.

6.5 UNDERGROUND UTILITIES

Various forms of underground utility lines or pipes may be encountered during intrusive work activities. To prevent this, a geophysical clearance will be performed for all intended drilling locations.

Should intrusive operations cause equipment to come into contact with utility lines, the SSO and the H&SP will be notified immediately, and a Supervisor's Report of Incident (see Attachment A) will be completed. Work will be suspended until the appropriate actions for the particular situations can be taken.

6.6 CHEMICAL EXPOSURE MONITORING PROCEDURES

This section presents monitoring procedures that will be employed during site investigation activities to assess employee exposure to chemical and physical hazards. Monitoring will consist primarily of onsite determination of various parameters (e.g., airborne contaminant concentrations and heat stress effects), but may be supplemented by more sophisticated monitoring techniques, if necessary.

6.6.1 Monitoring Instrumentation

To assess the exposure potential to environmental contaminants during sampling procedures, onsite monitoring will be performed using the following types of real-time instrumentation

Table 6-1: Air Monitoring Instrumentation

Instrument	Manufacturer/Model*	Substances Detected
Photoionization Detector (PID) (10.2 eV bulb)	RAE Systems mini-RAE Photovac Microtip HNu Model HNu	Petroleum hydrocarbons Organic Solvents
Colorimetric Detector Tubes	Sensidyne Draeger	Benzene 0.5-10 ppm
Aerosol Monitor	MIE Model PDM-3	Aerosols

Note: * Or similar unit, as approved by H&SP

All instruments will be calibrated on a daily basis in accordance with the manufacturer's written procedures for each device. Calibration information for each instrument will be recorded in the site log.

The following monitoring procedures and response action levels will be used for each of the site types to be sampled.

6.6.2 Monitoring Procedures – HSA Drilling Activities

Contaminants, which may be encountered during HSA drilling include PHs and VOCs. Monitoring for VOCs and airborne particulate matter (aerosols) will be conducted whenever HSA drilling operations are in progress. Table 6-2 provides the necessary guidance, as well as the appropriate response procedures based on on-site readings.

6.6.3 Monitoring Procedures – Landfill Delineation Activities

Contaminants, which may be encountered during trench activities include PHs and VOCs. Monitoring for VOCs and airborne particulate matter (aerosols) will be conducted whenever landfill delineation are in progress. Table 6-2 provides the necessary guidance, as well as the appropriate response procedures based on on-site readings. There will be no trench entry involved.

Table 6-2: Trenching/HSA Drilling Procedure Action Levels

Parameter	Zone Location and Monitoring Interval	Response Level (Above Background)	Response Activity
VOCs (total by PID)	Breathing Zone, every 30 minutes during intrusive activities	< 15 units	Continue work in required PPE and continue monitoring.
		15–50 units (sustained for more than 5 minutes)	Contact the SSO, implement mitigation measures, upgrade PPE to Level C (organic vapor cartridge), continue monitoring, and use benzene detector tubes.
		> 50 units (sustained for more than 5 minutes)	Cease work, exit, and contact the H&SP and CTO Manager.
Benzene (by Colorimetric Tube)	Breathing zone, where indicated by VOC readings	No color change	Continue work activities.
		Any color change	Cease work, exit the area, and contact the H&SP and CTO manager.
VOCs (total by PID)	Edge of Exclusion Zone, every 30 minutes during intrusive activities	< 15 units	Continue work in required PPE and continue monitoring.
		> 15 units (sustained for more than 5 minutes)	Cease work and contact the H&SP and CTO Manager.

Note: All VOC monitoring will be conducted using PID only.

6.7 RADIOLOGICAL MONITORING

During intrusive operations (operations) the use of direct reading instruments will be required to quantify the dose rate associated with beta/gamma emission. The monitoring instrument employed for direct field measurements of radiation must be a "pancake" G-M detector employing a thin-windowed halogen-quenched detector assembly. Such a detector assembly is commonly available as a hand-held instrument. An alternative instrument meeting the above performance requirements is acceptable as a substitute with approval from the H&SP.

As intrusive operations a radiation survey of the excavated soil will be performed by the SSO or designated alternate. The following procedure will be used to accomplish this task.

1. At the start of each workday, the performance of the meter will be established using a check source, following the manufacturer's standard procedures. Following this, a background radiation level will be established and recorded using soil known to be free

of radioactive contamination (contamination does not include any radioactive materials which occur naturally in the soil). A dose rate measurement will be taken at the surface of the "background" soil, as well as at distances of 1 foot and 1 meter from the surface. These background readings will be subtracted from all reading obtained during the day to determine the count rate (counts per minute – CPM), if any, from radioactive contaminants in the soil.

2. As soils are excavated readings will be taken at intervals of not more than every 15 minutes. Readings will also be taken of soil samples, which are collected. Readings will always be taken at the surface of the soil, and if necessary at a distance of 1 foot and 1 meter from the surface of the soil. The background readings established at the start of the work day will be subtracted from the dose rate readings obtained, and the results evaluated against with the action levels specified in Table 6-3.

If a radiological hazard to workers is determined to exist whole body dosimeters may be issued. Whole-body dose rates in excess of background readings are not expected to be encountered during field investigation sampling activities.

Table 6-3. Radiological Monitoring Levels

Measurement Location	Monitoring Interval	CPM	Response Action
Soil Surface	Every 15 minutes for spoils, all soil samples	< 5x background	No other monitoring required. Continue work in task-specified PPE.
		> 5x background and < 15x background	Begin monitoring rates at 1 foot from soil surface. Continue work in Modified Level D personal protective equipment.
		> 15x background	Cease work and contact the SSO and the H&SP.
1 foot from the soil surface	Every 15 minutes if surface rate exceeds 5 CPM but less than 15 CPM, continue every 15 minutes for spoils, and all soil samples	< 3x background	Continue work in Modified Level D personal protective equipment.
		> 3x background and < 10x background	Contact the SSO and the H&SP. Begin monitoring rates at 1 meter from soil surface.
		> 10x background	Cease work and contact the SSO and the H&SP.
1 meter from the soil surface	Every 15 minutes if 1 foot rate exceeds 3 CPM but less than 10 CPM, continue every 15 minutes for spoils, and all soil samples	< 5x background	Continue work in Modified Level D personal protective equipment.
		> 5x background	Cease work and contact the SSO and the H&SP.

Note: Comparison of readings should be made with the appropriate background reading obtained during function checks at the start of each workday.

7. PERSONAL PROTECTIVE EQUIPMENT AND DECONTAMINATION REQUIREMENTS

7.1 PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS

All use of protective equipment and clothing will comply with the following requirements.

7.1.1 General

Protective equipment (PPE) will meet the performance/certification requirements provided below. Task-specific PPE requirements are specified in the THAs found in Attachment D.

Head Protection

Employees will wear hard hats on work sites at all times unless otherwise specified in the HSP, other applicable H&S documentation, or directed by the SSO. Where necessary, ear protection and face shields may be attached to hard hats, provided the method of attachment does not compromise the integrity of the hard hat.

All hardhats shall meet the requirements set forth in American National Standards Institute (ANSI) Z89.1. Additional requirements (e.g., electrical or heat resistance) may be specified in the HSP or other applicable H&S documentation.

Eye Protection

Eye protection will be worn on work sites at all times unless otherwise directed by the SSO. All selected eye protection will meet the following minimum requirements:

- Provide adequate protection against the particular hazards for which they are designed
- Be reasonably comfortable when worn under the designated conditions
- Fit snugly and not unduly interfere with the wearer's movements
- Be durable
- Be easily cleaned and disinfected.

Where specified due to particular work conditions, eye protection must also meet the impact and durability standards set forth in ANSI Z87.1. However, where this is not specified the use of commercial sunglasses will be permitted at work sites (due to the limited potential for high velocity impact hazards associated with most Earth Tech work activities).

Persons whose vision requires correction and are required to wear eye protection may wear goggles or spectacles of one of the following types:

- Spectacles whose protective lenses provide optical correction (Rx)
- Goggles that can be worn over corrective (Rx) spectacles without disturbing the adjustment of the spectacles
- Goggles that incorporate corrective (Rx) lenses mounted behind the protective lenses.

Hearing Protection

Appropriate hearing protection (ear plugs, canal caps, or ear muffs) will be provided when noise may be a problem, such as around heavy machinery, power support equipment, and impact tools. All hearing protectors will provide a minimum noise reduction rating (NRR) of 25. Employees who may be exposed to hazardous noise must be participants in a hearing conservation program.

Foot Protection

Employees will wear appropriate foot protection while working on site, which will consist of leather or chemical-resistant boots (as appropriate) with safety toes. All footwear must meet the specifications of ANSI Z41.1.

Hand Protection

Employees will use appropriate hand protection when exposed to hazards that could cause injury to the hands. Gloves must resist puncturing and tearing as well as provide any necessary physical abrasion or chemical resistance.

7.1.2 HAZWOPER PPE Ensembles

Each task hazard analysis (see Attachment D) provides the task-specific requirements for PPE, however in general personnel performing sample collection activities will utilize a Level D ensemble, with the use of chemically protective gloves as appropriate. The following gloves will be acceptable:

Inner Gloves

- Best Safety Model N-Dex gloves (nitrile rubber)
- Other models approved on a case-by-case basis by the H&SP

Outer gloves

- Ansell Edmont Sol-Vex gloves (nitrile rubber)
- Other models approved on a case-by-case basis by the H&SP

Upgrades in PPE ensembles (Modified Level D, Level C, Level B or Level A) are not anticipated due to the low hazard potential associated with site activities and contaminants. If site conditions present a more significant inhalation or skin contact hazard than anticipated, work will cease and the H&SP will be contacted for additional guidance and development of revised/supplemental documentation.

Level D Ensemble

Level D protection is the lowest level of personal protection allowed on site. Respiratory protection is not required, since concentrations of airborne contaminants are expected to be below applicable action levels. The ensemble will consist of:

- Hard hat
- Short-sleeved shirt (tank tops are not acceptable)
- Long pants (shorts or cut-offs are not acceptable)

- Safety-toed work boots
- Safety glasses
- Hearing protection (as required).

For all intrusive operations and the collection and handling of samples personnel will use nitrile rubber protective gloves (Best Safety N-Dex or Solvex gloves (as desired) or equivalent).

Modified Level D Ensemble

If the potential exists for contact with chemical contaminants (e.g., minor splashes, "dirty operations," etc.), however the respiratory hazard is low, the use of a Modified Level D ensemble is appropriate. Modified Level D consists of protective clothing to preclude hazards due to contact with contaminated materials, but does not provide increased respiratory protection. The use of protective clothing in a Modified Level D ensemble can also serve to aid in personal cleaning and decontamination efforts through the use of disposable outer protective garments.

The use of Modified Level D PPE will be required for on-site operations where contact with contaminated soils can be expected (i.e., sample collection, soil handling/containerization). The Modified Level D ensemble provides moderate skin protection against chemical contact, but no respiratory protection. Upgrading to greater levels of protection will be executed as required in Tables 6-2 and 6-3.

Modified Level D Equipment List

- Chemical-resistant disposable outer coveralls (e.g., Tyvek or poly-coated Tyvek coveralls)
- Chemical-resistant outer gloves (taped to outer coveralls)
- Chemical-resistant inner gloves
- Hard hat
- Short-sleeved shirt (tank tops are not acceptable)
- Long pants (shorts or cut-offs are not acceptable)
- Safety-toed work boots
- Safety glasses
- Hearing protection (as required)

Level C Ensemble

Level C protection is defined by the use of a full-face, air-purifying respirator. This level of protection can be used when low levels of contaminants of a known nature are present, sufficient oxygen is available, and contaminants are not considered immediately dangerous to life or health (IDLH). The Level C ensemble provides considerable skin protection against chemical contact, and moderate respiratory protection.

Level C Equipment List

- Full-face air purifying respirator with organic vapor cartridges
- Chemical-resistant disposable outer coveralls (e.g., Tyvek or poly-coated Tyvek coveralls)
- Chemical-resistant outer gloves (taped to outer coveralls)
- Chemical-resistant inner gloves
- Hard hat-
- Short-sleeved shirt (tank tops are not acceptable)
- Long pants (shorts or cut-offs are not acceptable)
- Chemical-resistant safety-toe boots (taped to outer coveralls)
- Safety glasses
- Hearing protection (as required)

Level A and B Ensembles

The need for the use of Level A or Level B protective equipment during site activities is considered to be highly unlikely. Should conditions be encountered for which Level B is inadequate work operations will cease and the H&SP will be contacted for guidance. Work will not resume until the H&SP has approved supplemental mitigation procedures.

7.2 DECONTAMINATION ACTIVITIES**7.2.1 Personnel Decontamination**

Decontamination procedures must be carried out on all personnel who have been in contact with contaminated materials. Under no circumstances (except emergency evacuations) will personnel be allowed to leave a controlled work area where contaminants are exposed without performing decontamination.

A Personal Decontamination Station (PDS) will be established at the exit location of each controlled work area. The PDS will allow a soap and water washing and water rinse of exterior protective gear to remove contaminants, followed by doffing of the gear. To accomplish this, the specific PDS set-up/procedures will be established based on the level of protective equipment in use:

Level D Personnel Decontamination: Personnel exiting the Exclusion Zone while site activities require the use of Level D PPE will perform decontamination as follows

1. Place tools, instruments, samples and trash at the drop location. The equipment drop area should be clean and dry and at a minimum, plastic bags should be available for trash. Waste PPE will not be placed in the same containers as general trash.
2. Inspect equipment, samples, and if applicable, tools for signs of residual amounts of contamination or excessive soil buildup. If present, soils and contamination must be

completely cleaned off of equipment, samples, and tools prior to removal from the Exclusion Zone areas.

3. Personnel will visually check themselves for signs of excessive soils and possible contamination. If observed, soils and contamination will be completely removed before further decontamination is performed.
4. Prior to exiting the Exclusion Zone areas, personnel will wash their hands with soap and water in order to minimize the potential for contaminant exposure.

Modified Level D Personnel Decontamination: Where activities are performed in Modified Level D PPE personnel will perform decontamination as follows:

1. Place tools, instruments, samples and trash at the drop location. The equipment drop area should be clean and dry and at a minimum, plastic bags should be available for trash. Waste PPE will not be placed in the same containers as general trash.
2. Inspect equipment, samples, and if applicable, tools for signs of residual amounts of contamination or excessive soil buildup. If present, soils and contamination must be completely cleaned off of equipment, samples, and tools prior to removal from the exclusion zone areas.
3. Personnel will visually check themselves for signs of excessive soils and possible contamination. If observed, soils and contamination will be completely removed before further decontamination is performed.
4. Wash and rinse outer work gloves and boots (boot covers) with soap and water.
5. Wash/brush off outer protective coverall (Tyvek).
6. Untape wrists and ankles.
7. Remove outer work gloves and place them in an appropriate container specified for waste PPE.
8. Remove outer Tyvek coveralls and place them in an appropriate container specified for waste PPE.
9. Wash, rinse, and remove inner protective gloves and place them in an appropriate container specified for waste PPE.
10. Wash hands using soap and water (separate from other decontamination cleaners/solutions).

Level C Personnel Decontamination: Where activities are performed in Level C PPE personnel will perform decontamination as follows:

1. Place tools, instruments, samples and trash at the drop location. The equipment drop area should be clean and dry and at a minimum, plastic bags should be available for trash. Waste PPE will not be placed in the same containers as general trash.
2. Inspect equipment, samples and if applicable, tools for signs of residual amounts of contamination or excessive soil buildup. If present, soils and contamination must be

completely cleaned off of equipment, samples and tools prior removal from the exclusion zone areas. Personnel will visually check themselves for signs of excessive soils and possible contamination. If observed, soils and contamination will be completely removed before further decontamination is performed.

3. Wash and rinse outer work gloves and boots (boot covers) with soap and water.
4. Wash/brush off outer protective coverall (Tyvek).
5. Untape wrists and ankles.
6. Remove outer work gloves and place them in an appropriate container specified for waste PPE.
7. Remove outer Tyvek coveralls and place them in an appropriate container specified for waste PPE.
8. Remove respirator mask (also goggles if worn).
9. Wash, rinse, and remove inner protective gloves and place them in an appropriate container specified for waste PPE.
10. Wash hands using soap and water (separate from other decontamination cleaners/solutions).

Respirator Decontamination: Respirators will be decontaminated each day. Taken from the drop area, the masks will be disassembled, the cartridges disposed of and the rest placed in a cleansing solution. Personnel will inspect their own masks to be sure of proper strap readjustment for correct fit. Certain parts of contaminated respirators, such as the harness assembly or cloth components, are difficult to decontaminate. If grossly contaminated, they may have to be discarded, and replaced.

In addition to being decontaminated, all respirators, protective clothing, and other personal articles must be sanitized before they can be used again. The insides of masks and clothing become soiled from exhalation, body oils, and perspiration. The manufacturer's instructions should be followed in sanitizing the respirator mask. If practical, protective clothing should be machine washed after a thorough decontamination. Otherwise, it should be cleaned by hand.

7.2.2 Equipment Decontamination

Equipment that might require decontamination includes sampling equipment and tools. The following is general guidance for use in determining equipment decontamination procedures:

Hand Tools: Tools will be dropped into a plastic pail, tub or other container at the work site. They will be brushed off, washed with a detergent solution, and rinsed with clean water.

Sampling Equipment: Sampling equipment will be decontaminated before and between sampling to prevent cross contamination, and before removal from the work site, following the same procedure as for hand tools.

7.2.3 Disposal Of Decontamination Wastes

Solid and liquid decontamination waste should be containerized. Solids may be double bagged, or placed in a sealed drum or similar container. Liquids will be collected during decontamination and

placed in sealed containers. Containers must be clearly labeled for content, the operation from which they were filled, and the dates of accumulation.

8. EMERGENCY CONTINGENCY PLAN

There are four major categories of emergencies that could occur at the site during the site activities:

- Illnesses and physical injuries (including injury-causing chemical exposure)
- Spill or release of a hazardous material
- Catastrophic event (fire, explosion, earthquake)
- Safety equipment problems.

Although a catastrophic event or severe medical emergency is unlikely to occur during work activity at the site, an emergency contingency plan has been prepared for this project should such critical situations arise. The purpose of this plan is to establish the appropriate response actions for emergency situations, the means of communication, and the responsibilities of key personnel at the site.

8.1 RESPONSIBILITIES

8.1.1 Site Safety Officer (SSO)

The SSO will be the primary contact individual and coordinator of all emergency activities. He/she will be responsible for:

- Ensuring that emergency equipment, including fire extinguisher, eye-wash, and first aid kit are present at each work site
- Evaluating the severity of an emergency when it occurs
- Implementing an appropriate response action
- Summoning appropriate emergency services (fire department, ambulance, etc.)
- Notifying all site personnel, the H&SP, and concerned authorities of the emergency situation.

8.1.2 Other Onsite Personnel

It is the obligation of all personnel to inform the SSO of any emergency situation and to abide by their issued response actions. Special medical problems of field personnel such as allergies to insects, plants, prescription medication, etc. will be reported to the SSO.

8.2 EMERGENCY EQUIPMENT

The following emergency equipment will be available at the work site and in proper working condition.

8.2.1 First Aid Kit

A first aid kit will be available that meets the following requirements:

- First aid kits will be in weatherproof containers, be approved by the Earth Tech Occupational Physician, meet all regulatory requirements, and be present at all locations where Earth Tech employees are working
- Use of any item from the first aid kit necessitates completion of a Supervisor's Employee Injury Report. The report will be submitted to the Health and Safety department within one working day
- Personnel permitted to use first aid kits will possess a current first aid card. A minimum of two trained first aid/CPR provider will be present on site at all times
- The first aid kit will be located in the back of a specified truck or vehicle.

8.2.2 Fire Extinguisher

A fire extinguisher with a minimum rating of 1A, 10B, C will be available on site at all times. Site personnel will be trained in the use of the available fire extinguisher type(s), and will be kept aware of any on-site locations of where extinguishers are placed (for access in case of fire).

In addition, a fire extinguisher will be mounted on each piece of heavy equipment for use in an emergency. The minimum rating for each vehicle-mounted extinguisher will be 2A, 10B.

8.2.3 Eyewash Units

An eyewash unit will be available at the work site at all times. The eyewash must meet the latest requirements of ANSI Standard Z358.1, and will be capable of supplying hands-free irrigation for both eyes for at least 15 minutes at a flow rate of at least 0.4-gallon per minute.

8.3 RESPONSE ACTIONS—MEDICAL EMERGENCIES

A medical emergency is a situation that presents a significant threat to the health of personnel onsite. Chemical exposure, heat stress, cold stress, and/or poisonous insect bites can cause medical emergencies. Proper care must be initiated immediately. Proper care may be in the form of first aid treatment or emergency hospitalization.

Response personnel will accompany victims to the medical facility, whenever possible, to advise on decontamination. Table 8-1 provides response instructions for various medical emergencies.

Table 8-1: How to Respond to Medical Emergencies

Emergency	Response
Inhalation	<ol style="list-style-type: none"> 1. Call for medical assistance. 2. Workers wearing proper respiratory protective equipment should remove the victim from the contaminated atmosphere. 3. Voluntary basis only: If the victim is not breathing, administer mouth-to-mouth resuscitation or CPR immediately.
Eye Contact	<ol style="list-style-type: none"> 1. Do not rub eyes. 2. Flood eyes with emergency eyewash solution. Hold the eye open and flood so that all surfaces are thoroughly washed. 3. Continue washing for 15 minutes while calling for medical assistance.

Emergency	Response
Skin Exposure	<ol style="list-style-type: none"> 1. Wash skin with soap and water for a minimum of 15 minutes. All contaminated areas on the body, including hair, should be thoroughly decontaminated. 2. If clothing is contaminated, it should be removed in a way to minimize further contact with the substance. 3. Seek medical assistance.

8.3.1 Medical Assistance

The FM or SSO will keep on site the list of emergency telephone numbers and locations of the local fire department, hospitals, ambulance service, and other emergency services (see Table 8-2).

In the event of severe injury, transport personnel to the designated hospital. The address and phone number of that hospital is:

Irvine Medical Center

16200 Sand Canyon Road
Irvine, CA 92718
(949) 753-2250

The SSO will inform hospital personnel of non-emergency medical treatment administered to personnel for onsite injury, illness, or exposure to chemical contaminants.

8.4 RESPONSE ACTIONS—CATASTROPHIC EVENTS

In the event of a catastrophic incident:

1. Stop all work activities and evacuate all project personnel from the work location. Evacuate personnel in a direction opposite the critically affected area. Have personnel assemble in a pre-designated location outside of the job site.
2. Take a head count of the assembled employees. Administer first aid to any injured individuals.
3. Contact the SSO immediately, if the SSO is not currently present at the work location.

The SSO will designate (1) a universal signal for emergency evacuation (e.g., use of a horn) and (2) the evacuation assembly location. The SSO will communicate these designations to all field personnel during the initial site-specific training. The SSO will determine any changes in these designations mandated by changing site conditions, and will communicate these changes to workers during the daily tailgate safety briefing. The evacuation assembly location will be in the Contamination Reduction Zone. The evacuation route is indicated in the Hospital Route Map in Figure 8-1.

8.5 RESPONSE ACTIONS—SAFETY EQUIPMENT PROBLEMS

A malfunction or other problem with any health and safety equipment can potentially lead to a medical emergency. Examples include the following:

- Leaks or tears in protective clothing
- Failure of respiratory protective devices (i.e., self-contained breathing apparatus or air-purifying respirators)
- Encountering contaminants for which prescribed protective equipment may not be suitable.

These equipment problems must be corrected before proceeding with field activities. Personnel affected by the equipment problem(s) must exit the work area until the problem has been corrected.

Table 8-2: Emergency Telephone Numbers

Fire Department:	
Fire Department	911 or (949) 726-2333
Medical Care:	
Irvine Medical Center	(949) 753-2250
16200 Sand Canyon Road, Irvine, CA 92718	
Police:	
Local Police	911
Installation Emergency Service Desk	(949) 726-2172
Provost Marshal	911 or (949) 726-3525
Information and Response Organizations:	
National Response Center (if spill over RQ)	(800) 424-8802
Local Poison Control Center	(808) 484-5151
National Poison Control Center	(800) 458-5842
Navy Personnel:	
Resident Officer in Charge of Construction (ROICC), Scott Kehe	(949) 726-2506 or 726-2254
Remedial Project Manager, Kyle Olwenik	(619) 532-0789
Earth Tech Personnel:	
CLEAN II Program Health and Safety Manager, Robert M. Poll, CIH, CSP	(562) 951-2242
	Mobile: (562) 884-1414
CLEAN Technical Director, Ken Vinson, P.E.	(808) 471-9267
	Mobile: (808) 371-7441
CTO Manager, Crispin Wanyoike, P.E.	(562) 951-2057
	Mobile: (562) 577-4893
Site Safety Officer, Rod Lazo	(562) 951-2181
	Mobile: (562) 254-9232

Route to Irvine Medical Center:

From Site 3, travel south along North Marine Way, turn left onto Desert Storm Road to the intersection with Irvine Blvd. Turn left (north) to Irvine Blvd, and travel to the intersection with Sand Canyon Avenue. Turn left (south) on Sand Canyon Avenue, and follow for approximately 2 miles. Irvine Medical Center will be on the left immediately before the intersection of Sand Canyon Avenue and Alton Parkway.

From Site 5, travel east along Perimeter Rd. to Desert Storm Road, turn right to the intersection with Irvine Blvd. Turn left (north) to Irvine Blvd, and travel to the intersection with Sand Canyon Avenue. Turn left (south) on Sand Canyon Avenue, and follow for approximately 2 miles. Irvine Medical Center will be on the left immediately before the intersection of Sand Canyon Avenue and Alton Parkway.

C:\MELDAN\Navy\Hospital map_RDSites3.5.dwg, 03/21/2002 03:29:26 PM

SAND CANYON AVENUE

IRVINE BLVD






SITE 3

SITE 5

MSCR2

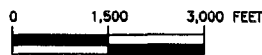
IRVINE MEDICAL CENTER
16200 SAND CANYON ROAD
IRVINE, CA 92718
(949) 753-2250

LEGEND

-  ROAD
-  IRP SITE
-  MCAS EL TORO BOUNDARY
-  HOSPITAL ROUTE
-  EMERGENCY EVACUATION MEETING PLACE



NORTH



SCALE: 1" = 3,000'

Health and Safety Plan		Final (Interim)	
Hospital Location Map			
Remedial Design IRP Sites 3 & 5			
Date 03-02	Former MCAS El Toro		Figure 8-1
Project No. 37380	EARTH  TECH A tyco INTERNATIONAL LTD. COMPANY		

9. REFERENCES

Earth Tech, Inc. (Earth Tech). 2002a. *Draft Work Plan, Removal Site Evaluation, Anomaly Area 3, Marine Corps Air Station, El Toro, California*. Honolulu. January.

_____. 2002b. *Final Work Plan, Pre-Design Investigation, Operable Unit 2C, Landfill Sites 3 and 5, Former MCAS El Toro, California*. Honolulu. February.

Attachment A
Health and Safety Forms

Supervisor's Report of Incident

This is an official document to be initiated by the injured employee's Supervisor. Please answer all questions completely. Fax to your Region's EHS Manager within 24 hours of the injury. See reverse side for instructions.

Section 1: Employee (Must complete each item or processing delays will occur) - Print Clearly

SCMS Claim#: _____		WC Location Code: _____	
SCMS: (877)261-8926			
Employee Data		S.S. No.	Sex
Injured's Name		Home Phone	Marital Status
Home Address		City	State
Job Title	Dept No.	Office Location/Address	
<input type="checkbox"/> Injury	<input type="checkbox"/> Illness	<input type="checkbox"/> Vehicle Injury	<input type="checkbox"/> Near Miss
		Hire Date	Hourly Wage

Section 2: Supervisor (Must complete each item or processing delays will occur) - Print Clearly

Date of Incident	Time	Date Reported	To Whom
Client Name	Job Assignment at Time of Incident		Time Shift Began
Exact Location & Address of Incident		Did injured leave work? <input type="checkbox"/> Yes <input type="checkbox"/> No	
Has injured returned to work? <input type="checkbox"/> Yes <input type="checkbox"/> No		When?	
Did employee miss a regularly scheduled shift? <input type="checkbox"/> Yes <input type="checkbox"/> No			
Doctor/Hospital Name		Address of Hosp.	
Witness Name		Statements Attached <input type="checkbox"/> Yes <input type="checkbox"/> No	
Nature of Injury		Body Part	
Medical Treatment Received			
Describe Incident			
What caused the incident?			
Corrective Action(s) to Prevent Future Occurrence:			
Supervisor/Foreman (Print Name)	Signature	Date	Telephone

Section 3: Manager

Comments on incident and corrective action			
Manager (Print Name)	Signature	Date	Telephone

Section 4: Environmental, Health and Safety

Concur with action taken? <input type="checkbox"/> Yes <input type="checkbox"/> No Remarks:			
OSHA Recordable <input type="checkbox"/> No <input type="checkbox"/> Pending <input type="checkbox"/> Yes - Type : <input type="checkbox"/> Incident only <input type="checkbox"/> First aid <input type="checkbox"/> Medical <input type="checkbox"/> Fatality Lost work days _____ Days of restricted activity _____			
EHS Professional (Print Name)	Signature	Date	Telephone

Supervisor's Report of Incident Instructions For Completion

The following types of incidents must be reported using this form:

1. Occupational Injury or Illness (includes first aid only, medical treatment, hospitalization, fatality)
2. Vehicle Accident Injuries
3. Near Miss (incident where employee(s) could have been injured)

INSTRUCTIONS

Immediate:

1. Employees must report such incidents to their Supervisor **immediately**.
2. The Supervisor must complete **Sections 1 and 2, Employee Data and the Supervisor Section** of the SRI. Incomplete items will delay timely processing. Any work-related injury or illness that requires medical treatment or care will require notifying SCMS at 877-261-8926 (Note: The WC Location Code is the employee's office's ET Office Code, preceded by the letter "C", e.g. Long Beach is C100).
3. The Supervisor must verbally notify his/her Manager, who in turn must sign **Section 3, Manager**, of the SRI. To avoid delaying SRI process, a separate copy of the SRI with the Manager's signature can be faxed within 3 days to the REHSM.
4. The Supervisor must verbally notify his/her REHSM with a follow-up SRI faxed within 24 hours (see below for fax numbers). The REHSM will review and complete **Section 4, Environmental Health and Safety**, and fax the SRI to the WCA at 804-515-8313.
5. For near-miss situations that could have resulted in an injury to an employee, the Supervisor must notify his/her Manager (see Item 3 above) and the REHSM with a follow-up SRI faxed within 24 hours.

PRIMARY CONTACTS

East REHSM: Dale Prokopchak, CIH, CSP
Telephone: 804-515-8556
Fax: 804-515-8313
Pager: 877-830-1981

WCA:
Telephone: 804-515-8557
Fax: 804-515-8313

Midwest REHSM: Jeff Grant, CIH
Telephone: 616-940-4426
Fax: 616-940-4396
Cell Phone: 734-516-5232

West REHSM: Bob Poll, CIH, CSP
Telephone: 562-951-2242
Fax: 562-495-9257
Cell Phone: 562-884-1414

Earth Tech, Inc.
Tailgate Safety Briefing Sign-in Log
Date: Time:

Briefing Conducted By:	Signature:	Company Name:
------------------------	------------	---------------

Company Name:

TOPICS COVERED: General PPE usage	Decontamination Procedures Smoking, Eating, and Drinking	Existing Work Zones Lockout/Tagout Safety
---	---	--

Hearing Conservation	
Respiratory Protection	
Personal Hygiene	
Exposure Guidelines	

- Slips, Trips, and Falls
- Heat Stress
- Site Control
- Emergency Procedures

Excavation/Confined Space Safety New Work Procedures

Printed Name	Signature	Company Name
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[illegible][illegible][illegible]

Attachment B
General Safety Rules for Subcontractors

General Safety Rules for Contractors

Introduction

The rules and requirements contained in this attachment have been written for the guidance of Contractors who are performing work under contract with Earth Tech. This booklet prescribes general requirements. Additional specific rules may be necessary to ensure the safety of workers on a particular job. The Contractor, working in collaboration with the Earth Tech representative, will be expected to establish such additional rules and procedures as may be necessary to conduct a safe operation and comply with all Earth Tech, regulatory, and insurance requirements and those of our clients. Earth Tech health and safety professionals are available to assist.

The term Contractor, as used in this attachment, shall be understood to include any and all persons, sole proprietorships, partnerships, corporations, or other business ventures under contract, oral or written, to Earth Tech.

Contractor is responsible for informing its subcontractors of these requirements, for directing and supervising work of subcontractors, and for assuring that its subcontractors adhere to the requirements herein. Earth Tech may request Contractor to provide proof of its subcontractor's adherence to all rules and regulations and will prohibit access to Earth Tech property or job sites or our client's property for those Contractors not in compliance.

In order to assist Contractor in following these instructions, a Earth Tech Representative will be assigned to the Contractor to act as Earth Tech's agent in all matters relative to work activities at Earth Tech facilities or job sites. Under no circumstances shall any work be started until the Earth Tech Representative has been contacted, a job orientation has been conducted by the Earth Tech Representative, and all permits, insurance, Earth Tech, client, and regulatory pre-job requirements met.

The Earth Tech Representative and the Earth Tech Health and Safety professionals are authorized to stop any work which they may consider hazardous to Earth Tech personnel or equipment or Contractor personnel. This authority may be delegated to appropriate individuals.

General Safety Rules and Requirements

Accident Reporting

All accidents (personal and property damage) shall be reported orally to the Earth Tech Representative as soon as emergency conditions no longer exist. A written report shall follow within 7 days after emergency conditions are resolved.

Alcohol, Firearms, etc.

Alcoholic beverages, illegal drugs or narcotics, or guns and ammunition are not permitted on Earth Tech property or job sites. Personnel under the

influence of alcohol or drugs shall not be allowed on Earth Tech property or job sites.

Approvals

The Contractor shall be required to obtain pertinent work permits or authorization and approval from the Earth Tech Representative before:

- Working on existing pipelines or equipment
- Entering tanks or closed vessels
- Entering any designated high-hazard areas
- Using torches, electrodes, electronic motors, forges, soldering irons, any open flames, or any device which could produce sparks or ignition source
- Closing walkways, roads, or restricting traffic
- Starting excavations
- Removing tanks from excavations
- Backfilling excavations
- Using utilities such as steam, water, compressed air, or electricity
- Sandblasting, spray painting, or guniting
- Storing flammable materials such as gasoline, oil, paints, oxygen cylinders, etc.
- Walking or working on roofs of buildings or equipment
- Drilling, boring, preparing test pits, or using geophysical equipment or any other exploratory equipment requiring penetration of surfaces
- Operating cranes or similar equipment near overhead power lines or pipelines
- Opening cutting through firewalls or berms
- Fueling or repairing Contractor operating equipment on Earth Tech property or job sites.

Security

For security reasons, entrance to and exit of Earth Tech facilities and job sites is restricted to those areas designated as the Contractor's work area.

Speed Limits

All vehicles on Earth Tech job sites and facilities must observe a maximum speed limit of 10 mph unless otherwise posted.

Vehicle Safety

- All vehicles must be parked in authorized areas only.

General Safety Rules for Contractors

- There will be no passing of moving vehicles at job sites where there are narrow roads and short-sight distances.
- Vehicles will only be operated by personnel with valid licenses and good driving records.
- Vehicles shall have all required inspection and operating permits.
- Seat belts shall be used.

Safe Work Practices

Communication

Communication and coordination is vital to prevent accidents on construction sites. Every worker must be aware of equipment operating in his vicinity.

Confined Space Entry

Confined spaces include storage tanks, bins, sewers, in-ground vaults, degreasers, boilers, vessels, tunnels, manholes, pits, etc. These enclosures, because of inadequate ventilation and/or the introduction of hazardous gases and vapors, may present conditions that could produce asphyxiation or injury.

Before entering a confined space, Contractor must notify the Earth Tech Representative of intent to enter. The Earth Tech Representative will review with Contractor the safe entry requirements which include:

Removal of Contents. Before entering, confined spaces should be as clean and free of hazardous materials and chemicals as possible. Where appropriate, confined spaces may be purged by water or other suitable means. Purging with hazardous solvents should be avoided where possible.

Isolation. All input lines which discharged into the confined space shall be disconnected and capped or isolated. The use of a single in-line valve shut-off as the sole means of isolating the confined space from any input lines is prohibited.

However, the use of a double in-line valving arrangement with a vent or drain in between the two valves is acceptable provided that dangerous air contaminants are not introduced by such venting. Isolation valves shall be locked closed, vent or drain valves shall be locked open, and the key shall be kept by that person performing the job.

Electrical Lockout. Where electrical devices located within the confined space (motors, switches, etc.) are to be repaired or worked on, the line-disconnect switches supplying the power must be tagged and locked in the "OFF" position. The lock key is to be kept by the person performing the job, and only this person is authorized to unlock the switch and remove the tag upon completion of the job. Where more than one person is working on the line, each must place a lock on the switch and retain his own key.

- Where there are multiple sources of power to an electrical device that supplies power to

the device through an automatic or manual bus transfer switch, lockout devices must be placed on the breaker nearest to the electrical device that is to be isolated, and an electrician shall test the power supply lines to ensure that power has been secured.

- Line-disconnect switches supplying power to any mechanical apparatus in the confined space (mixers, conveyors, etc.) must also be tagged and locked in the "OFF" position. This must be done for any entry, even though work will not be performed on the apparatus itself.

Securing of Covers. All manhole and cleanout covers shall be removed and the openings maintained clear of any obstructions. When hinged doors or lids are provided, they shall be secured so they cannot close. See **Excavations and Trenches** for guarding requirements.

Testing Atmosphere. A qualified person (NIOSH Publication No. 80-106) using only equipment approved and tagged for Class 1, Division 1 locations shall make appropriate tests of the atmosphere in the confined space and place a record of the test results at the entrance to the confined space. Testing shall ensure the following:

- Combustible gas and vapor concentrations do not exceed 10 percent of the lower explosive limit
- Oxygen content is no less than 20 percent and no greater than 25 percent
- Appropriate respiratory protective equipment and other appropriate personal protective devices have been provided for all employees when concentrations of toxic materials exceed established threshold limit values (TLVs).

Continuous Monitoring. If the nature of the work to be performed introduces, or has the potential to introduce, harmful air contaminants, continuous monitoring of the atmosphere and/or the oxygen content drops below 20 percent, all personnel shall evacuate the confined space immediately.

Ventilation. All confined spaces found to be unsafe must be ventilated by means of mechanical exhaust systems arranged so as to avoid recirculating contaminated air. The Contractor must contact the Earth Tech Representative to obtain approval not to ventilate. Personnel shall be evacuated immediately in the event of failure of the mechanical ventilation system. The confined space shall be retested prior to reentry following ventilation system repair.

Buddy System. At least two workers shall remain outside the confined space. One standby worker shall be stationed just outside the access opening of the any confined space while such space is occupied. This person shall:

- Maintain continuous awareness of the activities and well-being of the occupant in the confined space

General Safety Rules for Contractors

- Be able to maintain communication at all times
- Be alert and fully capable of quickly summoning help
- Be physically able and equipped to assist in the rescue of an occupant from a confined space under emergency conditions.

Safety Gear and Personal Protective Equipment.

All Contractor employees must be instructed in accordance with OSHA regulations regarding safety gear and personal protective clothing, hard hats, respirators, lifelines, and harnesses. Such instructions shall be received and documented before entering any confined space.

Compressed Gas Cylinders

Valve protection caps. Valve protection caps shall be in place when compressed gas cylinders are transported, moved, or stored.

Cylinder valves. Cylinder valves shall be closed when work is finished and when cylinders are empty or are moved.

Compressed gas cylinders. Compressed gas cylinders shall be secured against rolling or tipping (roped or chained) at all times, except when cylinders are actually being hoisted or carried.

Gas regulators. Gas regulators shall be in proper working order while in use.

Leaks. If a leak develops in a gas cylinder, after donning appropriate safety equipment, immediately remove it to a safe location. If the leak cannot be corrected, report it to the Earth Tech Representative.

Identification of Contents. Cylinders should be permanently marked or stenciled to identify the type of gas in the cylinder.

Breathing Air. All compressed breathing air shall meet OSHA specifications for breathing air quality. All compressed breathing air cylinders shall have their contents checked at the job site for correct oxygen concentration and rejected for breathing air if the oxygen concentration is not $20.7\% \pm 0.2\%$.

Oil and oily rags. Oil and oily rags shall be kept away from oxygen equipment.

Cranes, Hoists, and Other Heavy Equipment

Contractor personnel will not be permitted to use hoists and powered apparatus belonging to Earth Tech unless approval is obtained in each instance from the Earth Tech Representative.

ROPs. Roll over protection shall be used when conditions or regulations call for such use.

Cutting or Welding

Hot Work/Welding/Burning. "Hot Work" authorization must be obtained from the Earth Tech Representative before any welding, cutting, or other "hot work" is done. "Hot work" permits and results of tests are to be submitted to the Earth Tech Representative at the completion of the job or at the end of each workday.

Welding Flash. Noncombustible or flame-proof shields or screens must be provided to protect welder or others who might be harmed by direct rays or arc.

Personal Protective Equipment. Goggles, gloves, aprons, and other personal protective equipment appropriate to the job shall be used.

High Fire-Hazard Areas

- Contractor personnel are responsible to see that a fire watch is maintained and all adjacent combustible materials are protected or removed as designated by the Earth Tech Representative.
- Contractor shall provide his own calibrated combustible gas meter or other instruments for checking areas before hot work.
- Documentation of calibration shall be submitted to the Earth Tech Representative for review by the Earth Tech Health and Safety Section.
- Contractor is responsible for all testing and monitoring required by applicable regulations and to assure work place safety.
- Earth Tech shall have the right, not the responsibility, to perform additional testing. Earth Tech testing shall not be in lieu of Contractor's requirements.
- In the event of a bona fide emergency, such as emergency spill response work, and where the Contractor warrants that he cannot conduct the required testing, Earth Tech may upon written agreement then conduct all tests necessary to assure safety and regulatory compliance. The Contractor shall cosign the "hot work" permit form when tests are conducted by Earth Tech personnel.
- Contractor shall provide his own fire extinguisher(s) for welding and cutting, as designated by the Earth Tech Representative.

Electrical Safety

Grounding. The noncurrent-carrying metal parts of fixed, portable, or plug-connected equipment shall be grounded. Since ground wires can break, they shall be tested with an electrical resistance meter to assure conductivity as often as necessary to assure safety. Portable tools and appliances protected by an approved system of double insulation need not be grounded.

Extension Cords. Extension Cords shall be the three-wire type for grounded tools (two-wire is permissible for double-insulated tools) and shall be protected from damage; do not fasten with staples or extend across an aisleway or walkway. Worn or frayed cords shall not be used. Cords shall not be run through doorways where the door could cut or damage them.

Light Bulbs. Exposed bulbs on temporary lights shall be guarded to prevent accidental contact, except

General Safety Rules for Contractors

where bulbs are deeply recessed in the reflector. Temporary lights shall not be suspended by their electric cords unless designed for this use. Explosion-proof bulb covers shall be used when contact with flammable vapors or gases is likely and shall meet Class I, Division I requirements.

Electrical Receptacles. Receptacles for attachment plugs shall be of the approved, dead-front, concealed contact type. Where different voltages, frequencies, or types of current are supplied, receptacles shall be of such design that attachment plugs are not interchangeable.

Wet Environments. Work done in wet environments shall require ground fault interrupters and water-tight connectors.

Emergency Equipment

Earth Tech's fire equipment is not to be moved, relocated, or otherwise rendered inaccessible unless specific permission is granted in each case by the Earth Tech Representative.

Self-contained breathing apparatus, first aid equipment, fire blankets, stretchers, eyewash fountains, and deluge showers are not to be moved, relocated, or blocked without the express permission of the Earth Tech Representative.

Excavations and Trenches

Permits. Before any excavation work begins, all required permits shall be obtained.

"Dig-Alert". Before any excavation work begins, the existence and location of underground pipes, electrical conductors, etc., must be determined by Contractor who shall in turn notify the Earth Tech Representative.

Cave In Protection. The walls and spaces of all excavations and trenches (which will be entered by people) more than 4 feet deep shall be guarded by shoring, sloping of the ground, or some other equivalent means, in accordance with Cal/OSHA regulations.

Daily Inspections. Daily inspections of excavations shall be made by the Contractor. If there is evidence of possible cave-in or slide, all work in the excavation shall cease until the necessary safeguards have been taken.

Egress. Trenches more than 4 feet deep shall have ladders or steps located so as to require 10 feet or less of lateral travel between means of access.

Backfill. All trenches shall be backfilled as soon as practical after work is completed and all associated equipment removed.

Housekeeping. All Contractor equipment, such as pipe, rebar, etc., shall be kept out of traffic lanes and access ways. Equipment shall be stored in a manner which ensures the safety of Earth Tech and Contractor employees at all times.

Fall In Protection. All trenches shall be completely guarded on all sides. Standard guardrails are preferred. However, when wooden or metal

barricades are used for trench guarding, they shall be spaced no further apart than 20 feet, and at least two feet from the edge of the trench. Such barricades shall be at least 36 inches high when erected.

- Battery-lighted barricades shall be used as follows:

- (1) A minimum of two battery-lighted barricades shall be used at corners, one on each side of the barricade.
- (2) At least one battery-lighted barricade shall be used where vehicular traffic approaches the trench at right angles.
- (3) Where trenches parallel roadway, distance between battery-lighted barricades shall not exceed 40 feet unless this requirement conflicts with Item (1), above, and additional units are required.
- (4) All battery-lighted units shall be serviced as necessary to ensure equipment is operating.

- Caution tape shall be stretched securely between barricades. The caution tape shall be at least 3/4-inch-wide and shall be yellow or yellow and black and may have the words "CAUTION - DO NOT ENTER."

- Barricaded sections immediately adjacent to where pedestrians cross trenches shall be arranged to direct pedestrians to the walkway or bridge.

Encroachment. Use of other trench excavating equipment, or storage of equipment or supplies within a distance equal to the depth of the trench, will not be permitted without approval by the Earth Tech Representative.

Bridges. All pedestrian bridges shall be of sufficient strength to prevent no greater vertical deflection than one-half inch when a 250-pound weight is applied to the center of the bridge.

- Handrails shall consist of intermediate and top rails on both sides of the bridge. The top rail shall be between 42 and 45 inches above the walking surface and be capable of withstanding a lateral force of 200 pounds against the center of the top rail.
- All surfaces which a person could reasonably contact should be sufficiently free of splinters, nails, or protrusions which may cause injury.
- All bridges intended for vehicular traffic shall be constructed to withstand twice the load of the heaviest vehicle anticipated.

Earth Grading Activity

Vest. All persons within an area where earthmoving are operating shall wear a safety vest or jacket at all times. Vests may be red, orange, or day-glo green in color, but bright or fluorescent orange is preferred.

General Safety Rules for Contractors

Significantly faded or damaged vest must be replaced.

Communication. Anytime a test pit is to be excavated, the technician shall notify the grading contractor's authorized representative for that area. That individual may be acting in the capacity as a dump man, operator, or supervisor from an independent vehicle. Advise that representative of the test pit location and request their cooperation to promote safety during the test period. This should include their advising those under their supervision of your existence in the grading area. Make a notation on your records of the name of the individual with whom you spoke so that the communication is documented.

- Provide notice to the grading contractor
- Identify location of test pit
- Request the cooperation through the completion of the tests and document accordingly.
- A flag must be affixed to any vehicle driving in an earth grading activity area and hazard warning lights shall be operated.

Flags. Every over-the-road vehicle operating in the area of earthmoving equipment activity must carry a flag. The flag must be at least 300 square inches in area with no dimension less than 12 inches. Flags must be high visibility red, orange, day-glo green and mounted approximately 12 feet above grade level.

Hazard Warning Lights. Every over-the-road vehicle operating in the area of earthmoving equipment activity must operate the hazard warning flashers at all times.

Rotating or Flashing Beacon. All vehicles stationary in the grading area shall use a rotating or flashing amber beacon or strobe light on the top of the cab of the vehicle during all field testing.

Orientation of Test Pits. The technician is responsible for selecting a test pit location. Of paramount concern is the technician's safety. The test pit should be located behind the established pattern of grading equipment and outside any existing patterns. The orientation of the pit should include the use of the technician's vehicle as a barrier to potential oncoming traffic. The waste pile created from the excavation of the test pit should be opposite the vehicle so that the test pit is positioned between the vehicle and the waste pile. A flag shall be placed immediately on top of the waste (spoil) pile, satisfying the same requirements as the vehicle flag.

Zone of Non-Encroachment. The location of the test pit must be selected so that no earthmoving equipment will approach closer than 50 feet from the center of the test pit. This is not only for the technician's safety, but to ensure the integrity of the test. Excessive vibration from the operation of earthmoving equipment operating too closely may impair the accuracy or spoil the test results.

Completion of Tests. Immediately upon completion of tests, record the data and withdraw flags and

vehicles outside the grading area to record notes and do calculations.

Fire Prevention

Earth Tech Representative, or his designee, is authorized to correct any condition which he may consider a fire hazard. In any emergency, the site personnel are authorized to act directly with Contractor's Foreman in regard to fire hazards without waiting for the Earth Tech Representative.

Floor Openings

Floor openings shall be guarded by substantial barriers, railings, and/or covering materials strong enough to sustain twice the load of pedestrians or vehicular traffic. Barriers will be supplied by the Contractor.

Where a danger of falling exists for personnel, elevated floor areas must be provided with guardrails. In addition, toeboards shall be provided when the possibility of falling objects striking personnel below exists.

High-Hazard Areas

Although this list may not be all inclusive, there are certain areas and operations at Earth Tech facilities and job sites where extra precautions must be taken because of the nature of the hazards. When starting up any operation, the Contractor is required to check with the Earth Tech Representative for a review of the safety and health rules which apply before entering any of the following areas:

- Confined spaces (tanks, manholes, vaults, pits, etc.)
- Laboratories
- Chemical storage and disposal areas.

The contractor is also required to check with the Earth Tech Representative before any work is done on a flammable gas or solvent line; a tank or vessel that presently contains, or has contained, a flammable material; and before making an excavation anyplace on the site.

Housekeeping

Material should be carefully stacked and located so that it does not block aisles, doors, self-contained breathing apparatus, fire extinguishers, fire blankets, stretchers, emergency eyewash fountains, emergency safety showers, fixed ladders, stairways, or electrical breaker panels.

- Nails protruding from boards must be removed or bent over.
- All work areas shall be kept clear of form and scrap lumber and all other debris.
- Combustible scrap, waste materials, and debris shall be removed at regular and frequent intervals.

General Safety Rules for Contractors

- Containers shall be provided for the collection and separation of refuse by type. Covers shall be provided on containers used for flammable, combustible, or harmful substances.
- Overhead storage of debris, tools, equipment, pipes, etc., is prohibited.
- At the end of each work day, Contractor shall provide for pick up of all debris such as paper, rags, empty cans and bottles, etc.

Ladders

The use of ladders with broken or missing rungs or steps, broken or split handrails, or with other faulty or defective construction is prohibited.

- Ladders must not be placed adjacent to a door unless the door is locked or guarded.
- Metal ladders shall not be used for electrical work.
- Tie off top of ladder to structure.

Medical Service and First Aid

Emergency Medical Service. Preplanned emergency medical service shall be provided as designated by Contractor and approved by the Earth Tech Representative.

First Aid Kit. Each Contractor shall provide a first aid kit for his employees which meets minimum OSHA requirements.

Mobile Cranes

Mobile cranes, including portable crane derricks, power shovels, or similar equipment, shall not be operated within ten feet of overhead electrical power lines.

Overhead Work

No overhead work shall be performed when, as a result of that work, the possibility of a falling object striking any person exists. Do not work above any person at any time.

Personal Protective Clothing and Equipment

In certain construction and maintenance operations, personal protective equipment such as safety glasses, chemical goggles, respirators, hard hats, and protective clothing is required. The type of protective equipment to be worn will be determined by the degree of exposure to the potential hazard. There will be very few occasions when hard hats and eye protection will not be required at Earth Tech job sites. When in doubt of the safety measures to be observed, Contractor shall contact the Earth Tech Health and Safety Section. This shall not, however, relieve Contractor of his responsibilities to determine appropriate protection.

Eye protection is required when engaging in such operations as the following:

- Drilling, chipping, grinding, wire brushing

- Handling caustics and acids
- Breaking bricks or concrete
- Hammering chisels, drift pins, etc.
- Burning or welding
- Other situations which create a possible eye hazard, e.g., chemical environments.

Photographs

Only Earth Tech photographers, with permission from DIPEF, are permitted to carry cameras or take pictures. If progress or finished construction photographs are desired, request for same should be made through the Earth Tech Representative.

Power Tools

Power and Air-Actuated Tools. Gasoline-powered, electric, or air-actuated tools are not to be used on Earth Tech property or job sites without prior approval of the Earth Tech Health and Safety Department. To obtain approval, Contractor must contact the Earth Tech Representative.

Explosive-Actuated Tools. Explosive-actuated (powder-actuated) fastening tools shall meet the design requirements in "American National Standard Safety Requirements for Explosive-Actuated Fastening Tools" (ANSI A10.3-1970). A tool which does not meet these design standards cannot be used.

- Power tools shall never be left unattended in a place where they would be available to unauthorized persons.
- Power tools shall not be used in explosive or flammable atmospheres.

Fall Protection

Appropriate fall protection, such as safety harness and lanyard, must be worn when worker is exposed to falling more than 6 feet. Lanyard or lifeline must be tied off to appropriate structure capable of supporting five times the weight of the person (nominal 1000 pounds).

- Appropriate fall protection, such as safety harness and lanyard, must be worn when working above eight feet on straight or extension ladders when the work involves pushing, pulling, or action which may dislodge the person from the ladder.
- Safety harnesses are also required on swinging or portable scaffolds when handrails and toeboards are not provided (eight feet or more above ground or floor level).
- Safety harnesses and lifelines (including extraction devices for top entry spaces) are required on all work performed in confined spaces where an oxygen deficiency or toxic vapors may exist.
- All lifelines shall be safety secured to stable and adequate supports.

General Safety Rules for Contractors

- Safety harnesses and lifelines must be worn on rooftops where there are no guardrails and where the work is within ten feet of the edge.

Salamanders

- "Hot work" authorization must be obtained from the Earth Tech Representative before using a salamander.
- Salamanders must be a Factory Mutual or Underwriters Laboratories-approved type.
- Position salamanders away from all combustible material to reduce the possibility of uncontrolled fire.
- Guard salamanders from traffic to prevent them from being overturned.

Scaffolds

All scaffolds, whether fabricated on site, purchased, or rented, shall conform to the specifications found in ANSI A10.8, Safety Requirements for Scaffolding. Rolling scaffolds shall maintain a three-to-one height-to-base ratio.

- The footing or anchorage for a scaffold shall be sound, rigid, and capable of carrying the maximum intended load without settling or displacement.
- Unstable objects, such as barrels, boxes, loose bricks, or concrete blocks, shall not be used to support scaffolds or planks.
- No scaffold shall be erected, moved, dismantled, or altered except under the supervision of competent persons.
- Scaffolds and their components shall be capable of supporting at least four times the maximum intended load without failure.
- Guardrails and toeboards shall be installed on all open sides and ends of platforms more than 10 feet above the ground or floor.
- Scaffolds measuring four to ten feet in height, and having a horizontal dimension of less than 45 inches, shall have standard guardrails installed on all open sides and ends of the platform.
- Wire, synthetic, or fiber rope used for suspended scaffolds shall be capable of supporting at least six times the rated load.
- No riveting, welding, burning, or open flame work shall be performed on any staging suspended by means of fiber or synthetic rope.
- Tested fiber or approved synthetic ropes shall be used for or near any work involving the use of corrosive substances.
- All scaffolds, boatswain's (bosun's) chairs, and other work access platforms shall conform to the requirements set forth in the

federal OSHA Regulations for Construction (29 CFR 1926.451) except where the specifications in ANSI A10.8 7 or state or local regulations are more rigorous.

Smoking and Open Flames

Smoking and the use of open flames are strictly prohibited in areas where flammable liquids, gases, or highly combustible materials are stored, handled, or processed. Obey "No Smoking" signs. Smoke only in designated areas.

Solvents and Paints

- Adequate ventilation must be maintained at all times when paints or solvents are used.
- Personnel should use proper respiratory protection and protective clothing when toxicity of the material requires such protection.
- Flammable solvents and materials must be used with extreme caution when possible sources of ignition exist.
- Flammable paints and solvents must be stored in an approved (Factory Mutual or Underwriters Laboratories) flammable liquids storage cabinet when storage is required inside the buildings. If an approved cabinet is not available, paints and solvents must be removed from the building when not in use.
- Flammable liquids must be dispensed in safety cans with flash arresters bearing a Factory Mutual or Underwriters Laboratories approval. These containers must be clearly identified as to their contents.
- Material Safety Data sheets, for materials used by the Contractor, shall be maintained by the Contractor, and a copy provided to the Earth Tech Representative.

Tarpaulins

When tarpaulins are required for the detection of hot slag, dust, paint drippings, etc., or as security barriers, they shall be flame-resistant and in good condition.

Tools

Hand and power tools shall be kept in safe operating condition. Mushroomed heads on cold chisels, star drills, etc., are unsafe and should not be used. Hammers should have handles which are not cracked, split, or broken.

Nonsparking tools may be necessary in certain areas where flammable materials are handled or where sparks could create an explosion.

Transporting Material and Equipment

Extreme care must be taken while carrying sections of pipe, conduit, and other materials to assure safety to Earth Tech, Contractor, and client personnel and

General Safety Rules for Contractors

property. This includes, but is not limited to, flagging and use of two people to carry pipe of lengths greater than 10 feet.

- Tools, materials, and equipment must not be left unattended in access ways.
- Tools, material, and equipment shall not be removed from the job site without permission of the Earth Tech Representative.

Walking and Work Surfaces

- Workroom floors shall be clean and, to the extent possible, dry.
- Drainage mats, platforms, or false floors should be used where wet processes are performed.
- Floors shall be free from protruding nails, splinters, holes, and loose boards or tiles.
- Permanent aisles or passageways shall be marked.
- Floor holes shall be protected by covers that leave no openings of more than one inch wide.
- Floor openings into which persons can accidentally walk shall be guarded by standard railing and toeboards.
- Open-sided floors, platforms, and runways higher than four feet shall be guarded by standard railings.
- Toeboards shall be used wherever people can pass below, or where hazardous equipment or materials are located below.

Warning Signs

All posted warning, safety, and security signs and barriers shall be observed. Additionally, Contractor shall provide warning signs, barriers, barricades, etc. wherever such protection is needed. Where signs and barricades do not provide adequate protection, particularly along a road, flagmen shall be used.

Regulatory References

- (a) *Standard Operating Safety Guides*, USEPA, November 1984
- (b) Title 29 of the Code of Federal Regulations, Part 1910 (29 CFR 1910), Occupational Safety and Health Standards (USDOL/OSHA), with special attention to Section .120, Hazardous Waste Operations and Emergency Response
- (c) Title 29 of the Code of Federal Regulations, Part 1926 (29 CFR 1926), Safety and Health Regulations for Construction (USDOL/OSHA), with special attention to Section 1926.65, Hazardous Waste Operations and Emergency Response

Contractors are expected to brief their employees on these requirements and enforce these rules with their employees. Earth Tech management may stop or suspend work at any time the Contractor fails to comply with Earth Tech rules and regulations.

Attachment C

Drill Rig Safety Guidelines

DRILL RIG SAFETY GUIDELINES

A. General Drilling Practices

Prior to the start of site work, the drilling subcontractor will inspect all drilling equipment. The inspection will be documented in the field records. If field operations last longer than 1 week, the drilling equipment inspection must be repeated on a weekly basis.

EARTH TECH will conduct geophysical clearance and determine the location of all underground utilities before the start of drilling operations. In addition to obtaining the utility locations from the client, EARTH TECH will make a utility survey of each drilling point. The utility survey shall include both magnetometer and ground-penetrating radar survey. Documentation that nearby utilities have been marked on the ground and that the drill site has been cleared shall be kept in the EARTH TECH project trailer and confirmed to the drilling subcontractor.

Drill rig maintenance and safety is the responsibility of the drilling subcontractor. The following information is provided as general guidelines for safe practices during drilling activities, and installation of monitoring/extraction wells.

1. No food or beverage will be consumed or stored in the work area.
2. EARTH TECH will contact appropriate utilities agency to survey, mark, and flag locations of buried utility lines.
3. Maintain orderly housekeeping on and around the drill rig.
4. Store tools, materials, and supplies to allow safe handling by drill crew members. Proper storage on racks or sills will prevent spreading, rolling, or sliding.
5. Avoid storage or transportation of tools, materials, or supplies within or on the drill rig derrick.
6. Maintain working surfaces free of obstructions or potentially hazardous substances.
7. Store gasoline only in containers specifically designed or approved for such use.
8. Wear eye protection when chipping, chiseling or breaking material that presents risk of flying objects.

9. The departing driller should inform the oncoming driller of any special hazards or ongoing work that may affect the safety of the crew.
10. Fire fighting equipment should not be tampered with and should not be removed for other than the intended fire fighting purposes or for servicing.
11. If lubrication fittings are not accessible with guards in place, machinery should be stopped for oil and greasing.
12. Rigging material equipment for material handling should be checked prior to use on each shift and as often as necessary to ensure it is safe. Defective rigging should be removed from service.
13. The area around the derrick ladder should be kept clear to provide unimpeded access to the ladder.
14. Work areas and walkways should not be obstructed.
15. The rotary table of the rig floor shall be kept free of obstructions and free of undue accumulation of oil, water, ice, or circulating fluids.

B. Moving Rig to Drilling Location

1. Inspect the route of travel before moving drill rig off-road. Note rocks, trees, erosion, and uneven surfaces.
2. Remove all passengers from the cab before moving drill rig onto rough or sloped terrain.
3. Engage multiple drive power trains (when available) on rig vehicle when mobilizing off-road.
4. Travel directly up or down grade on slopes when feasible. Avoid off-camber traverse approaches to drill sites.
5. Approach changes in grade squarely to avoid shifting loads or unexpected unweighting.
6. Use a spotter (person at grade) to provide guidance when vertical and lateral clearance is questionable.
7. Use hand brakes and block rigwheels when grades are steep.

DRILL RIG SAFETY GUIDELINES

8. Lower rig mast before moving rig.
9. Secure all loads to rig prior to off-road mobilization.
10. EARTH TECH will use geophysical techniques, or equivalent, to locate buried utility lines.

C. Raising Mast

1. Locate visually overhead and buried utilities prior to drilling operations.
2. Treat overhead electrical lines as if they were energized and maintain at least a 40-foot clearance.
3. EARTH TECH will contact appropriate utilities agency to manipulate and deactivate overhead service in areas that interfere with drilling operations. Do not attempt to handle utilities.
4. Stabilize and level each work site prior to drill rig setup.
5. The derrick must not be raised until the rig has been blocked, leveled, and chocked.
6. Note wind speed and direction to prevent overhead utility lines from contacting rig derrick. Allow at least a 20-foot clearance between rig mast and utility lines.

D. Hoisting Operations

1. Drillers should never engage the rotary clutch without watching the rotary table and ensuring it is clear of personnel and equipment.
2. Unless the draw works is equipped with an automatic feed control, the brake should not be left unattended without first being tied down.
3. Drill pipe or casing should not be picked up suddenly.
4. Drill pipe should not be hoisted until the driller is sure that the pipe is latched in the elevator, or the derrick man has signaled that he may safely hoist the pipe.
5. During instances of unusual loading of the derrick or mast, such as when making an unusually hard pull, only the driller

should be on the rig floor and no one should be on the rig or derrick.

6. The brakes on the draw works of every drilling rig should be tested by each driller, when he comes on shift, to determine whether they are in good order. The brakes should be thoroughly inspected by a competent individual each week.
7. A hoisting line with a load imposed should not be permitted to be in direct contact with any derrick member or stationary equipment, unless it has been specifically designed for line contact.
8. Workers should never stand near the well bore whenever any wire line device is being run.
9. Hoisting control stations should be kept clean and controls labeled as to their functions.
10. Inspect wire, rope, hoisting hardware, swivels, hooks, bearings, sheaves, guides, rollers, clutches, brakes for the following:
 - abrasions
 - breaks
 - wear
 - fatigue
 - corrosion
 - jamming
 - kinking.

11. Avoid the suspension of loads when hoist is unattended.
12. Prevent hoisting loads directly over field personnel.
13. Restrict hoisting operations during unfavorable environmental conditions such as rain or high winds.
14. Maintain safe hand distance from hoisting equipment (e.g., wire rope, hooks, pinch points) when slack is reduced.

E. Riding Hoisting Equipment

Under no circumstances will personnel be permitted to ride the traveling block or elevators, nor will the cat line be used as a personnel carrier.

F. Cat Line Operations

DRILL RIG SAFETY GUIDELINES

1. Only experienced workers will be allowed to operate the cat head controls. The kill switch must be clearly labeled and operational prior to operation of the cat line.
2. The cat head area must be kept free of obstructions and entanglements.
3. The operator should not use more wraps than necessary to pick up the load. More than one layer of wrapping is not permitted.
4. Personnel should not stand near, step over, or go under a cable or cat line that is under tension.
5. Employees rigging loads on cat lines should:
 - Keep out from under the load
 - Keep fingers and feet where they will not be crushed
 - Be sure to signal clearly when the load is being picked up
 - Use standard visual signals only and not depend on shouting to coworkers
 - Make sure the load is properly rigged, since a sudden jerk in the cat line will shift or drop the load.

G. Pipe Handling

1. Pipe should be loaded and unloaded, layer by layer, with the bottom layer pinned or blocked securely on all four corners. Each successive layer should be effectively blocked or chocked.
2. Workers should not be permitted on top of the load during loading, unloading, or transferring of pipe or rolling stock.
3. Employees should be instructed never to try to stop rolling pipe or casing; they should be instructed to stand clear of rolling pipe.
4. Slip handles should be used to lift and move slips. Employees should not be permitted to kick slips into position.
5. When pipe is being hoisted, personnel should not stand where the bottom end of the pipe could whip and strike them.
6. Pipe stored in racks, catwalks, or on flatbed trucks should be chocked to prevent rolling.

H. Derrick Operations

1. The derrick climber should be used whenever climbing the derrick. Personnel on the derrick should be tied off, or otherwise protected from falling when working in an unguarded elevated position.
2. All stands of pipe and drill collars racked in a derrick should be secured with rope or otherwise adequately secured.
3. Tools, derrick parts, or materials of any kind should not be thrown from the derrick.
4. The elevators must be properly clamped onto all pipe joints prior to the driller engaging the load.

I. Making and Breaking Joints

1. Tongs should be used for the initial making up and breaking of the joint. The rotary table should not be used for the initial breaking of a joint.
2. Employees making or breaking joints should not be permitted to stand within the arc of the tong handles when the tong pull line is under tension. Employees should handle the tongs only by the appropriate handles.
3. Employees should be trained in the safe use of spinning chains. Spinning chains should not be handled near the rotary table while it is in motion.

J. Drilling Operations

1. Begin auger borings slowly with the drive engine operating at low speed.
2. Establish a communication system between driller, helper, and geologist for responsibilities during drilling operations.
3. Engage auger to power coupling as recommended by manufacturer.
4. Restrict contact with power coupling or auger during rotation.
5. Prevent placing hands or feet under auger during rotation.

DRILL RIG SAFETY GUIDELINES

6. Prevent placing hands or feet under auger sections during hoisting over hard surfaces.
7. Avoid the removal of spoil cuttings with hands or feet.
8. Assure drill rig is in neutral and the augers are not rotating before cleaning augers.

Drill Rig Safety Inspection Checklist

Date _____ Equipment Model/Type _____

Project # _____ Serial or License # _____

Location _____ Owner/Operator _____

Place a (✓) in the "Yes" column if the requirement has been met. If a "No" is encountered, equipment must be removed from operation until the deficiency has been corrected. Describe deficiencies on page two of this form. Use the Comment column to note any additional information needed to certify the equipment.

Item Name	Requirement	Yes	No	Comment
Hydraulic systems controls and levers	No leak fittings or connections. Levers are in good operating condition. Fluid levels are full.			
Fuel, oil, water, and coolant lines	No leaks.			
Hoses	No leaks in hoses or connections. No signs of excessive wear, kinked or bent hoses.			
Gauges	Operational and visible to operator.			
Emergency kill switch and life line	Operational and accessible to operator.			
Shear pins	In place.			
Drive chains	No signs of excessive wear, broken or defective links.			
Parking brakes	Set and operational.			
Outriggers	No leaks. Set on pads (as necessary to avoid damage).			
Windshield Wipers	Operational.			
Lights (head, tail and running lights)	Operational and without cracked lenses.			
Back-up alarm	Operational, spotter used.			
Cables and ropes	No fraying, birdnesting, flattening, stretching. Must be braided or properly clamped at connections.			
Pulleys, drums and spools	No excessive wear or cracking.			
Derrick/Mast	Locked in position. Frame is not cracked or bent.			
Hoists	Properly spooled cable, rated to lift loads.			

Drill Rig Safety Inspection Checklist

Item Name	Requirement	Yes	No	Comment
Safety equipment	Safety harness, fire extinguisher, flares, safety reflectors, first aid kit, grounding wire for fueling, and spill response equipment (for fueling and repairs).			
Guards	Power take-offs (PTOs) and all rotating parts designed with guards. Guards must have warning labels.			
Miscellaneous (as applicable)	Diverter systems; auger and head seals; cyclones; grout plant guards; etc. (list): <ul style="list-style-type: none">•••			

DEFICIENCIES (Explain all negative response and list corrective actions; all deficiencies must be corrected before the rig is entered into service):

- 1.
- 2.
- 3.
- 4.
- 5.

Other Repairs or Routine Maintenance

Inspection Conducted and Certified by:
(Owner/Operator)

Print Name:

Signature

Date

Checklist Reviewed by:
(Earth Tech SSO or FM)

Print Name:

Signature

Date

Attachment D

Heavy Equipment Certification

1.0 PURPOSE

The purpose of this procedure is to present the minimum safety performance requirements for the operation of heavy equipment on Earth Tech projects. Project Managers are responsible for ensuring all equipment is certified and that the attached Machinery and Mechanized Equipment form has been submitted by equipment owners.

2.0 GENERAL REQUIREMENTS

Subcontractor equipment shall comply with all applicable requirements for material handling heavy equipment contained in 8 CCR Sections 1590 - 1596. Heavy equipment includes, but is not limited to, drill rigs, front end loaders, backhoes/skiploaders, trackhoes, bulldozers, forklifts, and similar equipment used for the implementation of the project Statement of Work.

2.1 EQUIPMENT SAFETY INSPECTIONS

The following presents general guidelines for certifying equipment is in safe operating condition before activities commence at the site and during site operations. The following guidelines are not meant to be all inclusive.

- All machinery and mechanized equipment will be certified to be in safe operating condition (using the attached form) by a competent individual seven days prior to onsite operation, and is valid for one year.
- Equipment will be inspected on a daily basis by the owner/operator and daily logs will be maintained. All discrepancies shall be corrected prior to placing the equipment in service.
- Inspections shall include, but are not limited to: all hydraulic lines and fittings for wear and damage, all cable systems and pull ropes for damage and proper installation, exhaust systems, brake systems, and drill controls, etc.
- Exhaustive preventive maintenance shall be conducted for all equipment according to manufacturer recommendations and/or the Subcontractor's internal policies, schedules, and equipment SOPs.
- Machinery and mechanized equipment shall be operated only by designated qualified persons.
- Records of tests and inspections shall be maintained at the site by the contractor, and shall be made available upon request of the designated authority, and shall become part of the official project file.
- Equipment not found to be in safe operating condition, or when a deficiency which affects the safe operation of the equipment, shall immediately be taken out of service and its use prohibited until safe conditions have been corrected.
- All equipment shall be kept in the exclusion zone until work or the shift has been completed. Equipment will be decontaminated within designated decontamination areas.
- Equipment with an obstructed rear view must have an audible alarm that sounds when equipment is moving in reverse.

TO: Earth Tech

DATE:

FROM:

Project Name::

Project Location:

1. This form provides certification of machinery and mechanized equipment to be used on the referenced project for the following work:

Description of equipment work:	
Project Site:	
Subcontractor providing equipment: Address:	
Dates (duration) of equipment work:	

2. Inspection and certification of machinery and mechanized equipment, as required by Earth Tech has been made prior to, but within seven calendar days advance of, use on the project site. Re-certification will be required for equipment that is used on the project site for more than one year.

Identification of equipment (make, model, serial no.)		Date of Certification
1		
2		
3		

3. The above listed equipment has been inspected and tested as indicated above, and is **CERTIFIED TO BE IN SAFE OPERATING CONDITION BY THE FOLLOWING COMPETENT INDIVIDUAL:**

Name		Title	
Company			
Signature		Date	

4. If there are any questions regarding this certification, please contact the following Earth Tech representative: _____.

Attachment E
Trenching/Excavation Checklist

PROJECT INFORMATION

Project Name:

Project Number:

Project Manager:

Site Safety Officer:

Competent Person:

TRENCHING/EXCAVATION INSPECTION REQUIREMENTS

Visual Test:

- ☐ Cohesive
☐ Granular
☐ Fissured

Manual Test:

- ☐ Cohesive
☐ Granular

Soil Classification:

- ☐ Stable Rock
☐ Class A

- ☐ Class B
☐ Class C

Protective Measures/Equipment:

- ☐ Slope 1 1/2H:1V Type C
☐ Slope 1H:1V Type B
☐ Slope 3/4 H:1V Type A
☐ Special Engineered Design (submit copy to EHS Department)
☐ Horizontal
☐ Vertical

- ☐ Trench Shoring Box
☐ Manufacturer's Tabulated Data
☐ Correct Shore/Shield
☐ Slope Used _____

Encumbrances Identified:

- ☐ Above Ground (explain): _____
☐ Below Ground (explain): _____
☐ Surcharge Loads (explain): _____

General Considerations:

- ☐ Ladder/Ramps
☐ Hazardous Atmosphere
☐ Spoil Material Placement
☐ Water Accumulation

- ☐ Utility Locations
☐ Other: _____
☐ Notes: _____

1. Has the daily inspection of the excavation site been made by the competent person? ☐ yes ☐ no ☐ n/a
2. Are employees who are exposed to vehicular traffic wearing warning vests? ☐ yes ☐ no ☐ n/a
3. Are employees being kept out from under suspended loads? ☐ yes ☐ no ☐ n/a
4. Before opening any excavation, have efforts been made to determine if there are underground utility installation in the area? ☐ yes ☐ no ☐ n/a
5. If there are underground utility installations, have utility companies been contacted before excavation was started? ☐ yes ☐ no ☐ n/a
6. If underground utility installations are located, have they been protected, braced or removed to safeguard employees? ☐ yes ☐ no ☐ n/a
7. Have all surface encumbrances been removed? ☐ yes ☐ no ☐ n/a
8. In excavations into which employees are required to enter, have excavated or other materials been effectively stored and retained at least 2 feet or more from the edge of the excavation? ☐ yes ☐ no ☐ n/a
9. Do trenches >4 feet deep or more have adequate means of exit: ladders or steps? (no more than 25 feet of travel is required) ☐ yes ☐ no ☐ na
10. Have steps been taken to protect employees from loose rock and hazards of falling rock? ☐ yes ☐ no ☐ n/a
11. Do the walls and faces of trenches 5 feet or deeper and all excavations in which employees are exposed to danger from moving ground or a cave-in have a protection system, i.e. Shoring, sloping or some other equivalent means? ☐ yes ☐ no ☐ n/a
12. Is there any evidence of a possible cave-in or slide? ☐ yes ☐ no ☐ n/a if yes, all work in the excavation must cease until the necessary precautions have been taken to safeguard the employees.
13. Have guardrails been provided when employees are required to cross a walkway at an excavation site? ☐ yes ☐ no ☐ n/a
14. If excavation is remote, such as a well, pit or shaft, have physical barriers been provided? ☐ yes ☐ no ☐ n/a
15. Have structural ramps used solely by employees been designed by a competent person? ☐ yes ☐ no ☐ n/a
16. Do the structural ramps have appropriate means provided to prevent slipping and are the runways uniform in thickness? ☐ yes ☐ no ☐ n/a
17. Has a barricade, stop log or hand signal been provided when equipment is required close to the excavation? ☐ yes ☐ no ☐ n/a
18. Are sidewalks, pavements, etc. Protected from undercuts? ☐ yes ☐ no ☐ n/a
19. Have adjoining buildings, walls, etc. Been braced or otherwise supported? ☐ yes ☐ no ☐ n/a
20. Has the air around the excavation site been tested to make sure an oxygen deficiency or hazardous atmosphere does not exist? ☐ yes ☐ no ☐ n/a
21. If hazardous atmosphere does exist, has proper personal protective equipment been provided? ☐ yes ☐ no ☐ n/a
22. Is water accumulation a problem? ☐ yes ☐ no ☐ n/a if yes, are employees in the excavation site protected and equipment monitored by a competent person? ☐ yes ☐ no ☐ n/a

Completed By:

Print Name

Signature

Date

Attachment F
Task Hazard Analyses

Evaluated by: Robert M. Poll, CIH, CSP

Date: March 2002

TASK NAME

SUBSURFACE CLEARANCE

TASK DESCRIPTION

Personnel will perform an evaluation of records prior to the establishment of preliminary locations of trenches. This will be performed prior to excavation or sampling. Only a geophysical survey will be conducted in the MSCR2 site.

CHEMICAL EXPOSURE HAZARDS

None

PPE

Level D Ensemble (Section 7.1.2)

- Hard Hat
- Work uniform
- Safety-toe Boots
- Safety Glasses

OTHER SAFETY EQUIPMENT

None.

PHYSICAL HAZARDS

- Slips, trips, falls

APPLICABLE OPERATIONAL SAFETY PROCEDURES

- Slips, Trips, Falls, and Protruding Objects (Section 6.1)

ADDITIONAL SAFETY CONSIDERATIONS

None

MONITORING PROCEDURES

No monitoring required.

Evaluated by: Robert M. Poll, CIH, CSP

Date: March 200

TASK NAME

PERIMETER VAPOR SAMPLING

TASK DESCRIPTION

Samples will be collected using a vacuum pump and Tedlar bag for total VOC fixed gases.

CHEMICAL EXPOSURE HAZARDS

- PHs (dermal and inhalation)
- BTEX (dermal and inhalation)
- Solvents (dermal and inhalation)

Note: Only limited data is available to indicate which contaminants may be present.

PPE

Level D Ensemble (Section 7.1.2)

- Hard Hat
- Work uniform
- Safety-toe Boots
- Safety Glasses

OTHER SAFETY EQUIPMENT

- First aid kit
- Fire extinguisher

PHYSICAL HAZARDS

- Slips, trips, falls

APPLICABLE OPERATIONAL SAFETY PROCEDURES

- Slips, Trips, Falls, and Protruding Objects (Section 6.1)

ADDITIONAL SAFETY CONSIDERATIONS

None

MONITORING PROCEDURES

No monitoring required.

evaluated by: Robert M. Poll, CIH, CSP

Date: March 2002

TASK NAME

SUBSURFACE SOIL SAMPLING

TASK DESCRIPTION

Up to 7 samples will be collected at Site 3 and up to 4 samples will be collected at Site 5 using a shovel/bucket collected from the trench for geotechnical analysis. In the case of APHO 46, confirmatory soil samples will be collected using a backhoe at the bottom and along the sides of the trench. Soil samples taken from APHO 46 will be conducted following excavation of debris to for contamination.

CHEMICAL EXPOSURE HAZARDS

None

PPE

Level D Ensemble (Section 7.1.2)

- Hard Hat
- Work uniform
- Safety-toe Boots
- Safety Glasses

NOTE: In addition, personnel will wear chemically-protective outer gloves (SOLVEX) when collecting and handling samples or handling augers

OTHER SAFETY EQUIPMENT

- First aid kit
- Fire extinguisher

PHYSICAL HAZARDS

- Slips, Trips, Falls
- Hazardous Noise

APPLICABLE OPERATIONAL SAFETY PROCEDURES

- Slips, Trips, Falls, and Protruding Objects (Section 6.1)
- Hazardous Noise Environments (Section 6.2)

ADDITIONAL SAFETY CONSIDERATIONS

None

MONITORING PROCEDURES

Concurrent with excavation activities.

Evaluated by: Robert M. Poll, CIH, CSP

Date: March 200

TASK NAME

PERIMETER VAPOR WELL INSTALLATION (HAS DRILLING)

TASK DESCRIPTION

Six boreholes at Site 3 and four boreholes at Site 5 will be drilled using a hollow-stem auger (HSA) to total depth at least 5 feet above the seasonal groundwater table. Polyvinyl chloride (PVC) Schedule 40 casing will be used. Monitoring wells will be completed above ground using an 8-inch diameter lockable anodized aluminum well monument, with a concrete pad around the monument..

CHEMICAL EXPOSURE HAZARDS

- PHs (dermal and inhalation)
- BTEX (dermal and inhalation)
- Solvents (dermal and inhalation)

Note: Only limited data is available to indicate which contaminants may be present.

PPE

OTHER SAFETY EQUIPMENT

PHYSICAL HAZARDS

Level D Ensemble (Section 7.1.2)

- Hard Hat
- Work uniform
- Safety-toe Boots
- Safety Glasses

NOTE: In addition, personnel will wear chemically-protective outer gloves (SOLVEX) when collecting and handling samples or handling augers

- First aid kit
- Fire extinguisher

- Slips, Trips, Falls
- Hazardous Noise
- Drill Rig Safety

APPLICABLE OPERATIONAL SAFETY PROCEDURES

ADDITIONAL SAFETY CONSIDERATIONS

- Slips, Trips, Falls, and Protruding Objects (Section 6.1)
- Hazardous Noise Environments (Section 6.2)
- Drill Rig Safety Guidelines (Attachment C)

None

MONITORING PROCEDURES

Parameter	Zone Location and Monitoring Interval	Response Level (Above Background)	Response Activity
VOCs (total by PID)	Breathing Zone, every 30 minutes during intrusive activities	< 15 units	Continue work in required PPE and continue monitoring.
		15–50 units (sustained for more than 5 minutes)	Contact the SSO, implement mitigation measures, upgrade PPE to Level C (organic vapor cartridge).
		> 50 units (sustained for more than 5 minutes)	Cease work, exit, and contact the SSO and CTO manager.
VOCs (total by PID)	Edge of Exclusion Zones, every 30 minutes during intrusive activities	< 15 units	Continue work in required PPE, monitor air, and implement engineering controls.
		> 15 units (sustained for more than 5 minutes)	Continue mitigation measures and contact the SSO.

evaluated by: Robert M. Poll, CIH, CSP

Date: March 2002

TASK NAME

EXCAVATION/TRENCH ACTIVITIES

TASK DESCRIPTION

Personnel will excavate a 200 ft wide by 15ft deep trench to confirm lateral, landfill delineation at Sites 3 and 5. The trench will be excavated using a backhoe. A PID or FID will be used to screen excavated soil for VOCs or PHs, and used in trenches to monitor and detect any vapors. From the APHO 46 and MSCR2 site, shallow depths of debris/soil (approximately 1 foot) will be excavated using a backhoe and filled in Landfill Site 5. A radiological survey will also be performed on the excavated soil. There will be no trench entry involved.

CHEMICAL EXPOSURE HAZARDS

- PHs (dermal and inhalation)
- BTEX (dermal and inhalation)
- Solvents (dermal and inhalation)

Note: Only limited data is available to indicate which contaminants may be present.

PPE

OTHER SAFETY EQUIPMENT

PHYSICAL HAZARDS

Modified Level D Ensemble (Section 7.1.2)

- Hard Hat
- Tyvek coveralls
- Work uniform
- Inner and Outer chemically-protective gloves
- Safety-toe Boots
- Safety Glasses
- Traffic Safety Vest

NOTE: The backhoe operator can utilize a Level D PPE ensemble.

- First aid kit
- Fire extinguisher

- Slips, Trips, Falls
- Hazardous Noise

APPLICABLE OPERATIONAL SAFETY PROCEDURES

ADDITIONAL SAFETY CONSIDERATIONS

- Slips, Trips, Falls, and Protruding Objects (Section 6.1)
- Hazardous Noise Environments (Section 6.2)
- Heavy Equipment Operations (Section 6.3)

1. A Heavy Equipment Certification (Attachment D) must be completed for the backhoe operation prior to use on site.

MONITORING PROCEDURES

See attached page for air monitoring and radiological monitoring.

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Date: March 200

Parameter	Zone Location and Monitoring Interval	Response Level (Above Background)	Response Activity
VOCs (total by PID)	Breathing Zone, every 30 minutes during intrusive activities	< 15 units	Continue work in required PPE and continue monitoring.
		15–50 units (sustained for more than 5 minutes)	Contact the SSO, implement mitigation measures, upgrade PPE to Level C (organic vapor cartridge).
		> 50 units (sustained for more than 5 minutes)	Cease work, exit, and contact the SSO and CTO manager.
VOCs (total by PID)	Edge of Exclusion Zones, every 30 minutes during intrusive activities	< 15 units	Continue work in required PPE, monitor air, and implement engineering controls.
		> 15 units (sustained for more than 5 minutes)	Continue mitigation measures and contact the SSO.
Particulate Matter	Breathing Zone, every 30 minutes during intrusive activities	< 5 mg/m ³	Continue work activities.
		5 – 50 mg/m ³	Contact the SSO, implement mitigation measures, upgrade PPE to Level C (P100 particulate matter cartridges).
		> 50 mg/m ³	Cease work, exit the area, and contact the SSO and FM.

Measurement Location	Monitoring Interval	CPM	Response Action
Soil Surface	Every 15 minutes for spoils, all soil samples	< 5x background	No other monitoring required. Continue work in task-specified PPE.
		> 5x background and < 15x background	Begin monitoring rates at 1 foot from soil surface. Continue work in Modified Level D personal protective equipment.
		> 15x background	Cease work and contact the SSO and the H&SP.
1 foot from the soil surface	Every 15 minutes if surface rate exceeds 5 CPM but less than 15 CPM, continue every 15 minutes for spoils, and all soil samples	< 3x background	Continue work in Modified Level D personal protective equipment.
		> 3x background and < 10x background	Contact the SSO and the H&SP. Begin monitoring rates at 1 meter from soil surface.
		> 10x background	Cease work and contact the SSO and the H&SP.
1 meter from the soil surface	Every 15 minutes if 1 foot rate exceeds 3 CPM but less than 10 CPM, continue every 15 minutes for spoils, and all soil samples	< 5x background	Continue work in Modified Level D personal protective equipment.
		> 5x background	Cease work and contact the SSO and the H&SP.

Attachment G

Radiation and its Health Effects

Radiation and Its Health Effects

All matter is composed of submicroscopic atoms. An atom, in turn, is composed of a relatively small nucleus containing positively charged protons and neutrally charged neutrons, which is surrounded by a "cloud" or shell of negatively charged electrons (charges of protons and electrons are designated +1 and -1 respectively). To preserve the electrical neutrality of an atom, the number of protons exactly equals the number of electrons (under most conditions). By convention, the number of protons in the nucleus determines the chemical element. For example, any carbon nucleus has 6 protons, any uranium nucleus 92 protons. The number of neutrons in an atom may vary widely even for a given chemical element. For example carbon atoms may contain anywhere from three to ten neutrons (although only atoms with 6, 7 or 8 neutrons are found in nature). An atom of a given element may therefore be composed of varying numbers of neutrons without affecting its chemical properties. Atoms of the same chemical element with differing numbers of neutrons are referred to as isotopes of that element, and are designated by atomic weight (the total number of protons and neutrons), thus a carbon atom with 6 neutrons is called Carbon-12, while one with 8 neutrons is Carbon-14. More generally, a nuclide refers to an atom (really a nucleus) with a specific number each of protons and neutrons. Nuclides are designated by their chemical name followed by the mass number, which can also be abbreviated using the element's chemical symbol with its mass number as a superscript (e.g., C^{12} for Carbon-12). Some nuclides are stable but most are not, due to an imbalance in the proton to neutron ratio. Of the approximately 1,700 known nuclides, about 280 are stable.

Over a length of time that varies by nuclide, the structure of unstable nuclides (referred to as radionuclides) changes, or decays. This represents an attempt by the nucleus to reach a stable configuration by altering the proton to neutron ratio, and results in an instantaneous transformation of one chemical element into another. Several mechanisms for this decay, referred to as types of radiation, exist. Three primary radiations of significance are alpha radiation, beta radiation and gamma radiation. Not all nuclides emit more than one type of radiation, and virtually no radionuclides emit all three, however a mixture of several different radionuclides can easily present a wide combination of types and energies of radiation.

Alpha radiation is the result of the expulsion from the nucleus of an energetic particle composed of two protons and two neutrons. Because an alpha particle is heavy (atomic mass of four) it moves quite slowly. It also possesses a charge of +2 due to the presence of the two protons, which are not balanced by any electrons. Due to this combination of slow speed and large charge, alpha particles interact very strongly with their environment, causing electrons to be lost from atoms, which are encountered (referred to as ionizations). Alphas cause a large number of ionizations in a very small region, making the radiation extremely damaging, but also causing it to have a very short range, since each ionization removes energy from the alpha particle, which eventually stops and is absorbed into the material as a helium atom (by gaining two electrons). For this reason alpha radiation is of no consequence as an external exposure hazard, since alpha particles are completely stopped in the outer (dead) layers of skin, without reaching areas where damage could occur. If an alpha-emitting substance is introduced into the body however, the potential consequences can be particularly severe, since damage can be quite extensive within the limited area of the alpha particle's range.

Beta radiation is the result of the transformation of a neutron into a proton within a nucleus by emitting an electron (thus losing its neutral charge). Since beta particles are electrons, they have very little mass (1 proton weighs as much as 1,836 electrons) and therefore travel at a rapid rate. They also possess a smaller charge than an alpha particle (-1), and interact less strongly with their environment. As a result, beta particles produce fewer ionizations within a given region, require a greater distance to lose their energy, and have a greater range than alpha particles. Beta radiation can

pose a slight external exposure hazard, since higher energy beta particles can penetrate to the living layers of skin, however unless beta-emitting material enters the body, beta radiation will not effect sensitive internal organs.

A third type of radiation of significance is **gamma radiation**, or gamma rays. Following a radioactive decay (by alpha or beta decay), the resulting newly transformed nucleus is often left with an excess amount of energy. To lose this energy, the nucleus emits an electromagnetic energy "packet" or photon, which is similar in nature to light photons, although much more energetic. Unlike alpha and beta particles, these photons possess no mass or charge, and move at the speed of light. They interact by direct collision with atoms, again by ionizing the atom while losing some energy. Since the probability of a direct hit to an atom is small, gammas interact very weakly with their environment, and thus require a large distance to lose their energy. This gives them a considerable range relative to alphas or betas, however the amount of ionizations caused in a given region is also considerably less. Since it is so penetrating, gamma radiation easily passes through the body, affecting all body parts during this passage. Consequently, gamma emitters pose a potential external exposure hazard. It should be noted that **x-rays** are identical to gamma rays in all respects except point of origin. X-rays originate in the electron cloud rather than the nucleus. Thus x-rays behave identically with gamma rays, and all the above information concerning gamma ray hazards applies equally to x-rays.

The number of decays occurring in a radioactive material per unit time is expressed in units of the curie (Ci), which is 3.7×10^{10} disintegrations per second (approximately the activity of one gram of the radionuclide radium-226). Each radionuclide possesses a unique decay rate, referred to as its specific activity. This quantity expresses the number of atoms of the nuclide expected to be decaying in a given span of time for a specific quantity of the material, which is present, and is usually expressed in curies per unit mass of the material.

Ionization produced by radiation interaction in matter results in energy being deposited in the material. The energy imparted by radiation per unit mass of irradiated matter is called the absorbed dose, and can be expressed in units called rads; 1 rad being equal to the deposition of 0.01 joule of energy per kilogram (2.2 lbs) of the absorbing material.

Interaction of radiation with biological material can result in damage to the living tissue. The stronger the interaction of the radiation with matter, the more significant is the damage produced, thus alpha radiation is most effective in causing biological harm, while gammas are least effective. In order to assess the damage potential induced by exposure to a mixture of radiation types, it is necessary to be able to account for the relative damage potential for each radiation type. This is accomplished by multiplying the absorbed dose (in rads) by a quality factor, which accounts for relative biological harm. This yields a measure of biological harm, referred to as dose equivalent, which is the same for all types of radiation. For electromagnetic radiation (gamma rays and X rays) and beta particles, the quality factor is set at unity (1); for alpha particles, the quality factor is 20. The unit, which results from the combination of the absorbed dose and the quality factor is referred to as the rem. One rem of any radiation is always considered to cause equivalent biological damage, although it may represent vastly different energy depositions, thus rems of different types of radiation are additive, and can be summed to determine the overall biologically effective exposure received by an organism.

Radioactive materials have the potential to produce an exposure either through external means, primarily from gammas and some high-energy betas (both of which are penetrating and have long ranges), and internally due to deposition of alpha and beta emitting materials.

External doses are received equally throughout the body, and hence are referred to as "whole-body doses". Such doses occur due to the penetrating power of the radiation involved. Internal exposure is due to direct exposure of tissue to radioactive materials, which have entered the body. Such materials

can then chemically interact as would non-radioactive isotopes of the same elements, and are distributed to various parts of the body. Some materials even exhibit a tendency to collect in a particular organ or system, thus increasing the dosage received by that "target" system. For example iodine preferentially accumulates in the thyroid. The whole body and individual organ doses received (since dose is based upon energy absorbed per unit mass of material different body parts can receive different exposures) can therefore vary widely.

There are three exposure mechanisms of significance in analyzing internal exposure:

- Inhalation: breathing of airborne radioactive materials (this would occur during immersion) allows deposition in the lungs of particulates, which may later be absorbed, and direct passage into the body of radioactive gases.
- Ingestion: eating and drinking of contaminated plants, animals, and water can allow radioactive materials to enter the body through the digestive system. Once in the body, these materials will again behave as do their non-radioactive cousins, and will interact chemically in the body.
- Absorption: some radioactive materials can be absorbed directly through the skin, where they will again interact as other chemical materials in the body.

External exposures are received only during the period of actual exposure to radioactive releases. Internal exposures however are more persistent, since radioactive materials, which enter the body, may take a considerable time to be released, during which time radioactive decays continue to contribute to the total dosage received. As a result, the total dose received by a person as a result of a radioactive release has two components, the first is the external dose which is received during a short span of at most a few hours following release, and the long-term dose incurred as a result of internal deposition of radioactive materials. Such a dose may be distributed over a period of years.

Health Effects

If the whole body is exposed to a very high dose of radiation, death may occur immediately or within a matter of weeks. The dose that is lethal to about 50% of the exposed population within 60 days of exposure is about 500 rem (Abrahamson et al., 1989). If a limited area of the body is exposed briefly to a very high dose, death may not occur but there may be other early (sometimes called "acute") effects; for example, doses to the gonads (i.e., testes or ovaries) might cause sterility. Such effects are considered to be acute or short-term effect, and are due to massive damage to bodily systems. Such short-term health effects are usually not observed below an acute dose of about 25 rem, although changes in blood cells have been detected at doses as low as 5 rem (NCRP, 1971). No credible means for producing such exposures have been identified at SRMSC.

Doses of radiation that are well below the thresholds needed to produce observable acute effects may have consequences later in life. Such doses can produce chronic, or delayed, health effects, which can be broken down into two types, latent somatic effects and latent genetic effects.

Somatic effects are those directly observable in the exposed individual, the most important of which is the possible development of cancer 5 to 30 years after exposure. Although the basic processes by which radiation induces cancer may not be fully understood, studies of the survivors of the atomic bombings in Japan, of patients who have been exposed to radiation, of uranium workers, and of workers in the radium-luminizing industry in the 1930s have established that the incidence of cancer is greater in groups who were exposed to high doses of radiation in earlier years than in groups who were not exposed.

Latent genetic effects are those, which are observed in the offspring of exposed individuals, including effects, which may not become apparent for several generations. Latent genetic effects are due primarily to mutations in the genetic material of exposed persons.

The data that established a link between cancer and genetic effects, and radiation, were data for persons who received high doses; no equivalent statistical link has been established between cancer and low doses of radiation. However, a conservative assumption is that the probability of a delayed effect is proportional to dose (linear dose-risk relationship); therefore, a reduction in dose by one half would result in half the number of incidence persons developing the effect, a reduction by ten would result in a tenth the number of persons developing the effect, and so on.